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MARCH, 1935

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CITY, COUNTY AND STATE ENGINEERING AND CONSTRUCTION

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TIMEWASTERS

Solutions Later:

The Timewaster editor has been away from the office so much of late that solutions hardly reach him in time for inclusion in the issue just following that in which the problems appear. For that matter, this column has had to be made up in odd moments, when the opportunity occurred, here and there. Enough, here are a few to worry on.

The Horse Race:

Take out the four aces from a deck of cards (not a pinochle deck), lay the top seven cards of the deck face up, end to end along one side of the table and place the aces in a row at right angles to them. The aces are the horses, and are advanced parallel to the aforementioned seven cards, this constituting the race. The rate of advance is determined by taking the remaining 41 cards in the deck, placing them face down on the table, and turning the top cards, one by one. When a spade is turned, the ace of spades is advanced one card, and so forth. The ace that passes the last of the seven cards first is adjudged the winning horse, this requiring turning 8 cards of a suit.

The betting odds are determined by the number of each of the four suits appearing in the seven cards. If there are 3 clubs, 2 diamonds, two spades and no hearts, the odds are respectively, 3:1, 2:1, 2:1 and 1:2. If a single card of a suit appears on the table, the odds are 1:1; if four cards, 4:1. This game has quite a hold, out in the suburbs, and ye ed desires mathematical information on the best odds to lay his peanuts on. Are the odds as given fair, and which one should be bet on to get maximum returns?

The Old Army Game:

A courier starts from the rear of an army column 6 miles long to deliver a message to the colonel leading the front rank. When he returns to the rear of the column, it has advanced a distance of 4 miles. How far has he traveled? *John A. Bevan.*

Ikey and Mikey Go Hunting:

Ikey and Mikey went hunting. The sum of the squares of the number of shots fired by each was 2880. The product of the number of shots fired by Ikey and the number of shots fired by Mikey was equal to the sum of the squares of the number of birds killed by each of them. How many birds were killed by each hunter? *Also by John Bevan.*

Do you like "Timewasters"? If you do, and want them continued, tear off this corner and mail to me; or just say "OK Timewasters" on a card or in a letter. Your initials are enough. Just write: W. A. H., care PUBLIC WORKS.—W. A. H.

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A. PRESCOTT FOLWELL, *Editor* **W. A. HARDENBERGH,** *Asso. Editor*

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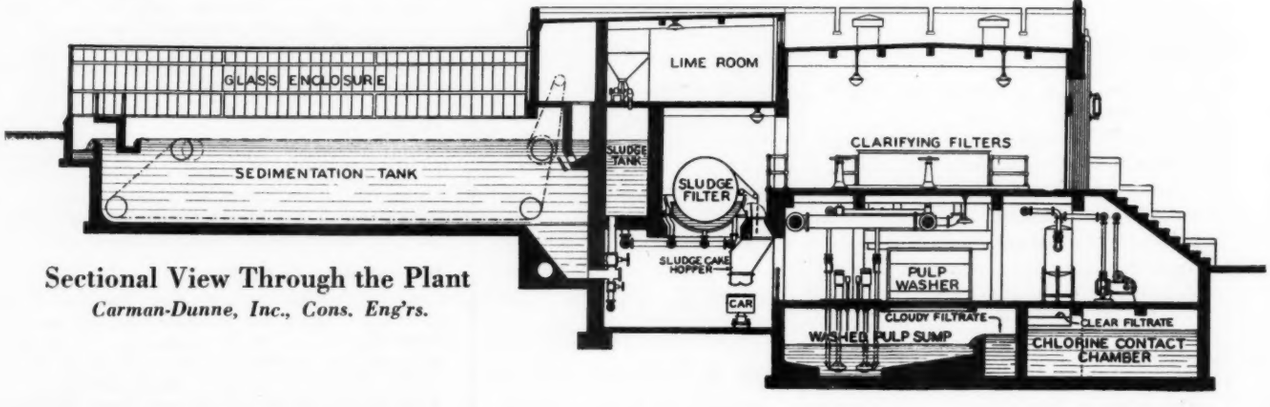

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PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 66 *March, 1935* No. 3

Pavement Construction in Oklahoma City Under Federal Relief

By Virden A. Rittgers

Office Engineer, Engineering Dept., Oklahoma City

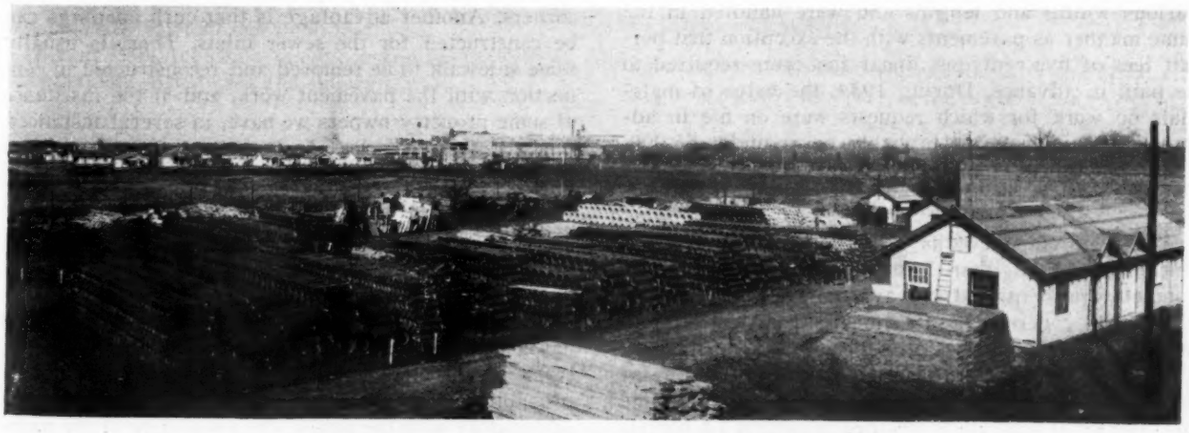
IN THE fall of 1931 the engineering department of Oklahoma City was just an "engineering" department, in the ordinary sense of the word. But in the fall of 1933 it was handling directly the construction of pavements, sidewalks, driveways, street gravelling and grading, and sanitary and storm sewers in all sections of the city. These additional responsibilities were assumed in order to carry out with dispatch a program using a force of CWA labor which reached a peak of 3,200 men. The city manager, Orval Mosier, aimed to employ 7,000 local unemployed in useful labor during the winter of 1933-1934, and assigned to City Engineer L. M. Bush the responsibility for planning and carrying out sound engineering projects which would employ about 3,000 of them.

Virden A. Rittgers

Two important conditions added to the difficulty of executing this program: First, the department personnel had been reduced 50% since 1931 and funds were not available for hiring additional employees; second, the restricted municipal budget did not provide for purchasing any appreciable amount of construction materials. Fortunately the department had engineering inspectors most of whom were experienced construction men. The second difficulty was relieved by the consent of the federal government to furnish materials up to 20% of the total cost of approved projects. This materials contribution ceased in April, 1934, after which the city turned to its property owners for increased cooperation in providing work projects. These projects of necessity were such as would be of direct benefit to abutting property, which ordinarily were constructed under contract by the special assessment method.

During 1932 and 1933 several miles of lateral sanitary sewers and a few small pavement widening projects had been built using "made work" labor and with the property owners furnishing the materials. Thus we knew that the program would work if only enough momentum could be gathered to keep up the volume. The department openly encouraged this type of sewer and pavement work and with the cooperation of the local press in carrying repeated news items on the idea, we found that each small project was leading to other projects. One unemployed but resourceful ex-contractor created a job for himself by associating with a local material dealer and promoting lateral sewer projects.

The handling of finances on lateral sewer work where the property owners furnished the materials was done



Centralized municipal warehouse and stock yard—Oklahoma City

by setting up a City Sewer Trust Fund Account. On each sewer line or separate project, the property owners were asked to deposit, in cash, the total estimated cost of materials and were issued the proper receipt or receipts. At first we refused to accept payments from any property owners until all who were to contribute on the particular sewer line involved were ready with their deposits. However, after considerable experience, we loosened up on this policy and accepted payments whenever offered, for we found that before making advance payments, a property owner would invariably contact his neighbors or others involved as to their attitude toward building the sewer. The deposits on hand at one time in this trust fund reached a peak of $4,701.37 and a total of $23,065.86 has been paid into the account to date. During the year 1934, the total paid into the account was $10,643.78. Through this fund, the city purchased sewer materials in reasonably large quantities, thus effecting a saving in cost. Materials were stored at the city's centralized warehouse and delivered to the various projects as required.

The construction of small pavement projects under the work relief program began, as previously stated, in 1932 and the volume of work continued to increase through 1933 and 1934. The method of handling the finances for the materials for pavement work was entirely different from that for the sanitary sewers. In fact, the city did not do the handling and this was really the preferred method. We simply asked the interested parties to make their own arrangements for materials with the local dealers and then to inform us from whom we were to order these materials. When cost or quantity estimates were wanted, we furnished them. Prior to 1934, the concrete, reinforcement steel and form lumber had to be arranged for and ordered from separate dealers, but during 1934 the local concrete companies began quoting property owners on all required materials for their various projects. Whereas, it was entirely impracticable to have from one to two dozen different property owners trying to furnish their portion of the various sewer materials for a block of sewer line, it was much simpler on the pavement work with the type of projects which we were called on to do. Nearly all of the pavement jobs were for widening of existing paving. A majority of the paving projects were less than one block in length and were usually constructed for an individual or a single company or institution. Our largest single project consisted of 3,033 square yards of 40-foot pavement.

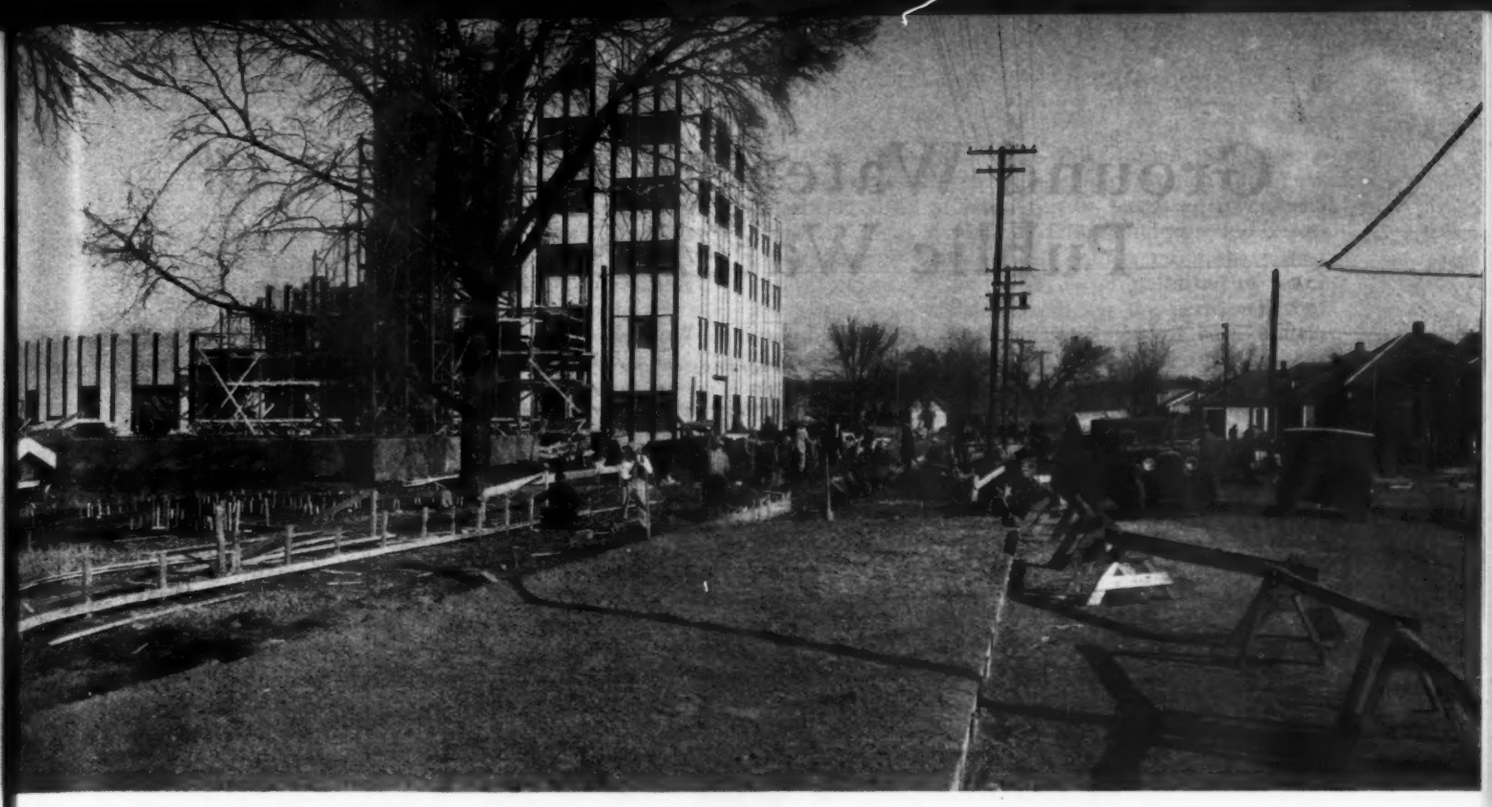
Driveways, both residential and commercial, were of various widths and lengths and were handled in the same manner as pavements with the exception that permit fees of five cents per linear foot were required to be paid in advance. During 1934, the value of materials on work for which requests were on file in advance in our office was probably never under $5,000, and at one time was as much as $15,000.

Construction Details

We required sidewalks to be constructed 4 inches thick and not less than 5 feet wide, using Class "B" concrete; residential driveways 6 inches thick, using Class "B" concrete; and commercial driveways and street pavement 6 inches or 7 inches thick, using City Paving Mix concrete (designated CPM), and reinforced with steel wire fabric placed 2 inches below the top. The CPM concrete is specified to contain 1.6 barrels of cement per cubic yard and not more than 5.5 gallons (total) of water per sack of cement. Standard test cylinders on this concrete break consistently above 4000 pounds per square inch. For relatively narrow pavement widening slabs, we use No. 5 gage steel wire fabric with longitudinal wires spaced 4 inches and transverse wires spaced 12 inches. For slabs in which the section between free joints approaches the shape of a square, we use No. 5 gage fabric with a 6″ x 6″ spacing of the wires. Half-inch transverse expansion joints are spaced 35 feet apart. Across these joints, we install ¾″ slip dowel bars 24″ long with ⅞″ x 6″ metal caps on the end. At the present time, we require a 12 inch spacing of these bars but in 1934 a 24 inch spacing was used. Pavement slabs are divided longitudinally so as to have no slab widths greater than 15 feet. Deformed construction joints are used with ⅝″ x 3′ 6″ tie bars spaced 2 feet or 4 feet on centers, depending on the total slab width. Most of our widening work abuts old pavement consisting of an asphalt top on a concrete base, and since we have found it unsatisfactory to place expansion joint material against an asphalt topped pavement, we use the relatively close expansion joint spacing of 35 feet in order to localize the relative movement between the new and the old slab edges.

We use a uniform slab thickness of 6 inches or 7 inches, depending on the location, for original full-width pavement work where we can install deformed and bonded longitudinal joints. However, on the widening work the slab edge is thickened next to the old pavement and "hairpin" corner bars are installed. This is done for two reason. First, this slab edge is usually located where it will receive a large portion of the street traffic, and second, the new and the old slabs cannot and, of course, should not be bonded together for strength. In a great many instances, the new slab is constructed from 1 inch to 3 inches above the old and worn asphaltic surface, and then the old surface is built up to grade along its outer portion. This method will permit of resurfacing the entire old pavement surface at some future date without leaving an excessive crown in the central portion of the pavement. One important thing which we always try to do in laying out pavement widening grades is to keep the gutter back at the curb, and continue the cross slope of the pavement from the curb to the center line. This gives a better appearing job, keeps the storm water out of the travelled portion of the street and leaves the pavement "banked" the proper way instead of the wrong way at corners. Another advantage is that curb openings can be constructed for the sewer inlets. There is usually some sidewalk to be removed and reconstructed in connection with the pavement work, and at the insistence of some property owners we have, in several instances, removed this walk in 5-foot squares and relaid it to grade. While this method is not entirely satisfactory, we realize that we must sometimes yield to the wishes of the property owners on things of this nature since, after all, the work depends on their voluntary contributions.

The cutting of corners at paved street intersections has a two-fold purpose: to facilitate the handling of traffic on the more important streets and to lessen the probability of accidents. The program has been highly satisfactory with the public. On a majority of the pave-



Pavement widening work under way. Old pavement (at right) will be built up to give a center crown

ment widening jobs and corner setbacks, there were existing storm sewer inlets to be rebuilt and reconnected. This provided an opportunity to increase the size and capacity of these structures, most of which were entirely inadequate. The city has furnished and paid for all materials used in these appurtenances.

For the corner cut or setback work, a work sheet was prepared in the office to enable and assist the survey crew in working out satisfactory grades. A sheet was required for each radius length. On the plan view of the corner were drawn a series of radial lines dividing the central angle into equal parts and a series of equally spaced concentric "riding" lines extending from the face of the new curb to the center lines of the intersecting streets. Below the plan view were provided appropriate spaces for readily plotting the profiles of the existing pavement along the two series of lines above mentioned. Grade lines were drawn for one series of lines and then checked by the other series. This method has proved to be quite practicable.

From September 1, 1931, to December 31, 1934, a total of 291 pavement corner cuts were made. On this work, the old radii varied from 6 feet to 15 feet and the new radii from 20 feet to 50 feet.

During 1934, the Department constructed the following pavement, driveways and sidewalk work:

6″ & 7″ RC pavement	16,713.42	sq. yds.
6″ plain & 7″ RC drives (mostly 6″)	12,109.5	sq. ft.
4″ sidewalks	124,245.9	sq. ft.
Number of pavement corner cuts and setbacks	60	

Cost of Work

The table gives data as to the costs of pavement work, including three contract jobs.

On Project No. 55-B1-135, the cost of engineering and supervision was $0.215 per square yard and the cost of trucks was $0.127 per square yard. This project cost more than the average because of placing narrow thickened-edge slabs between 13 railway tracks on a 300-foot railway crossing.

In order to handle the numerous small pavement projects in a workable manner, the city applied for and got approval on a blanket CWA project covering work anywhere within the city limits. The labor and supervision costs on these numerous small jobs naturally were greater than on larger jobs, but the total costs in no instance were as great as the costs on even the larger contract jobs.

Details of sewer construction methods and costs will be given by Mr. Rittgers in the April issue.

COST OF PAVEMENT, PER SQ. YD.

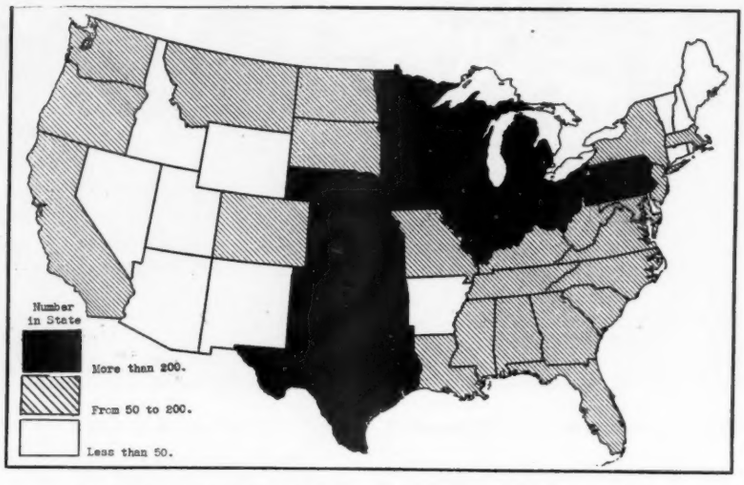
Project or Street Relief Work	*Type*	*Quantity*	*Cost Per Unit* *Materials*	*Labor*	*Supr., Equip., Engr.*	*Total*
55-B1-176	6″ RC	2,148 Sq. Yds.	1.79	0.46	0.33	2.58
55-B1-135	7″ RC	3,033 Sq. Yds.	1.83	0.98	0.34	3.15*
55-40C-3	7″ RC	6,215 Sq. Yds.	1.73	} Total for Labor, Supr., Equip. and Engr., $11,607.19		
55-40C-3	Asphalt on 6″ B.	1,164 Sq. Yds.	3.02			
55-40C-3	4″ sidewalk	13,003 Sq. Ft.	0.0925			
Contract Work in 1931						
Okla. Ave.	7″ RC	1,186 Sq. Yds.	(No curb on this job)			3.22*
16th St.	7″ RC	3,945 Sq. Yds.				4.10
May Ave.	7″ RC	3,694 Sq. Yds.				3.34*

*Drainage items have been taken out, for purposes of camparison.

Ground Water as a Source of Public Water Supplies

By Leland K. Wenzel
United States Geological Survey

GROUND water constitutes the direct or indirect source of supply for most of the public water works in the United States. Almost every community, whether large or small, depends somewhat on the recovery of ground water. The smaller cities and villages generally obtain water from wells or springs and their dependence on ground water is obvious. Most of the large cities utilize water obtained from streams, and generally this source of supply has not been thought of as being related to ground water. However, during the last few years of drought the significance of ground water in relation to the flow of streams has become more fully realized.



Map showing number of public water supplies derived from wells.

Municipal Ground-Water Supplies

About 6,500 public water supplies in the United States, out of a total of about 10,000, are derived from wells, according to estimates based on incomplete data recently collected by the United States Geological Survey. In 29 States more than half of the public water supplies are obtained from wells and in 16 States more than three-fourths of the supplies are obtained from this source. Texas, Iowa and Illinois apparently lead in the number of well water supplies, each State having more than 400.

The 25 largest cities in the United States obtain their public supplies principally from surface sources, but considerable ground water is used in some of these cities for private water supplies and by industries. The use of ground water for air cooling of buildings because of the relatively low and constant temperature of the ground water has increased greatly in the last few years and is likely to increase further in the future. The cities ranging from 5,000 to 25,000 in population are about equally divided between ground water and surface supplies; of those with more than 25,000 inhabitants, slightly over one-fourth obtain their supplies from wells; whereas of some 8,000 cities and villages with less than 5,000 inhabitants that have public supplies about two-thirds obtain their water from wells. It is roughly estimated that about 20,000,000 people in the United States depend upon public water supplies derived from wells.

The largest ground-water development for public water supplies is on Long Island, where about 100,000,000 gallons a day are pumped for the New York City Water Department, and about an equal amount is pumped for other supplies. The largest city supplied entirely from wells is Houston, with 292,000 inhabitants in 1930, where about 25,000,000 gallons a day are pumped for public supply, and about an equal amount is pumped from private wells. Among other large cities that obtain their water supplies from wells are Memphis, Dayton, Des Moines, Long Beach, Jacksonville, Camden, Spokane, El Paso, Sioux City and Lincoln.

Sources of Ground Water

Whether cities obtain water from wells, springs, or surface sources is largely a matter of location and population. There are many areas in the United States where large quantities of potable water can be recovered from underground sources without excessive depletion. However, there are other areas where only small quantities of ground water can be obtained and these from sources of doubtful permanency. Unfortunately, in many instances, large and permanent sources of ground water are located far from centers of population and hence can be utilized only to a small extent for public water supplies. In a stretch of about 40 miles along the canyon of the Snake River below Shoshone Falls, Idaho, there are large springs which have an aggregate discharge of more than 3,200,000,000 gallons of water a day. This quantity of water would easily supply the total water requirements of New York City, Chicago, Philadelphia, Detroit, Los Angeles, and Cleveland. There are other large springs located in Florida, Missouri, Texas, Oregon and Washington, the flow of any one of which would amply supply the water requirements for Washington, D. C.

Most of the large surface-water supplies for the great cities have been extensively investigated, and careful plans for future developments have been made by able hydraulic and sanitary engineers. On the other hand, the more numerous ground-water supplies have received much less attention partly because of the difficult problems arising from the complexity of the geologic structure that controls the occurrence, quantity and quality of the ground water. Basic investigations of the ground-water resources of the country have, however, long been in progress by the United States Geological Survey, generally in cooperation with State geological surveys or other State organizations. In some

of the States the State geological surveys have rendered valuable service to municipalities in regard to the available ground-water supplies. The work of the United States Geological Survey has been carried forward, often on a small scale and with inadequate funds, but nevertheless without complete interruption for more than 40 years, and as a result a large amount of reliable information in regard to the ground-water conditions in all parts of the country has been made available. The methods and results of the work of ground-water hydrologists in other countries have been studied and applied in this country, and in some respects the work has been carried beyond that of any of the other countries in the development of the basic principles of ground-water hydrology and the methods of ground-water work. A large part of this work has dealt with investigations, some quantitative and some regional, in which the yields and permanency of water-bearing formations have been determined, thus providing basic data for the planning and development of public supplies that utilize ground water.

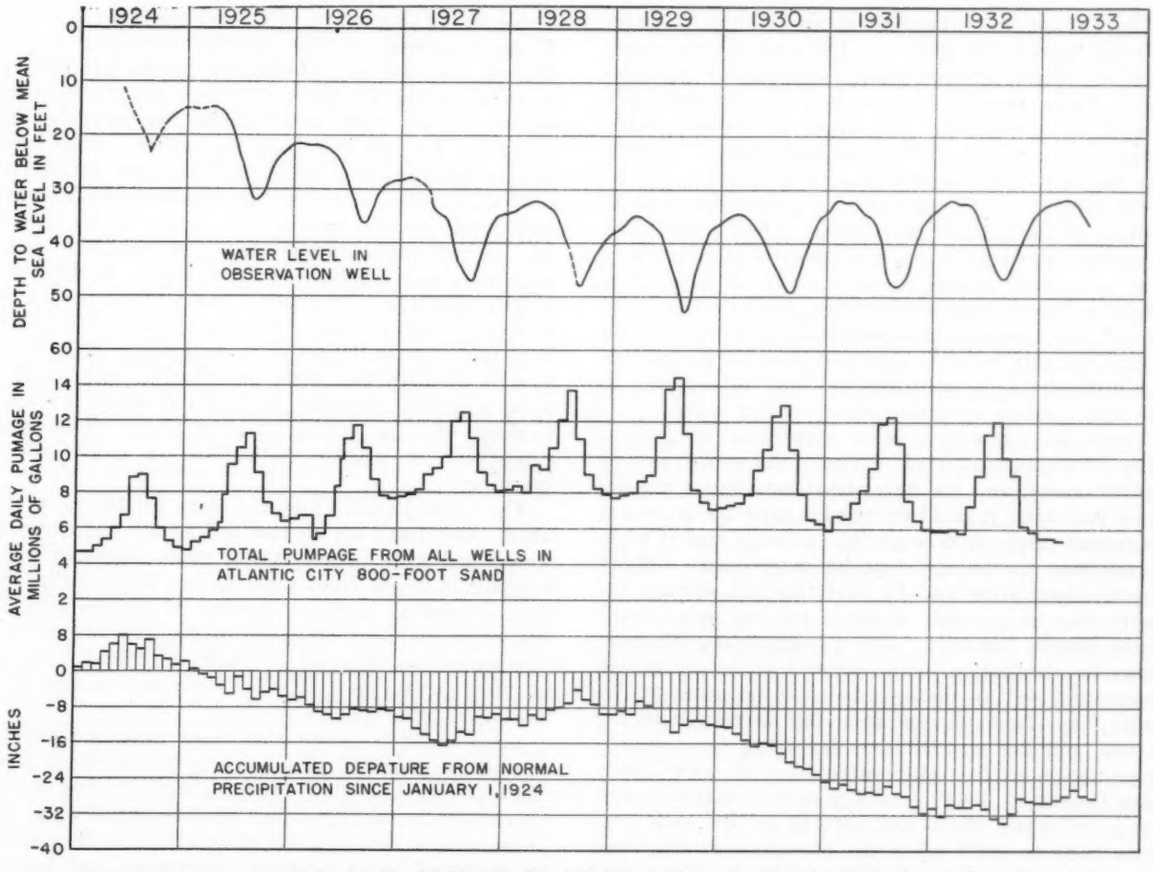
The geologic formations in which ground water is stored govern to a great extent the quantity and quality of the water that can be recovered. There are in the United States many distinct water-bearing formations that differ greatly in hydrologic properties and which yield water in various amounts and with various mineral constituents. Moreover the hydrologic properties of any one water-bearing formation may change greatly from place to place. Thus extremely complex conditions are encountered and almost every ground-water supply is a problem unique in itself.

The permanency of ground-water supplies depends primarily upon the storage capacity of the geologic formations, which constitute underground reservoirs, and upon the quantities of water added to them each year. Many underground reservoirs are small and only small quantities of water can be recovered from them without serious depletion. Other underground reservoirs underlie thousands of square miles, have vast storage capacities, and yield large quantities of water for many years without impairing the permanency of the supply. The holdover capacities of such underground reservoirs are large and public supplies that obtain water in these areas usually are not greatly influenced by droughts. It has been estimated by G. E. Condra, State Geologist of Nebraska, that the underground storage in that State amounts to over 900,000,000 acre-feet of water, equal to about 10 years cumulative precipitation. Much of this ground water is available for the public water supplies of the State.

Relation to Surface-Water Supplies

Most underground reservoirs have outlets where the water escapes to the surface and forms ponds, lakes or streams. Thus in an indirect way, public supplies that draw upon surface sources are dependent upon underground storage. When the underground reservoirs are filled to capacity the ground-water level is high and the overflow into the streams and lakes is at a maximum. The streams will then maintain a relatively large flow even throughout weeks and months with meager precipitation. Conversely, when the ground-water reservoirs are depleted the ground water level is low and the overflow is reduced to a minimum. The flow of streams may then decline greatly if the precipitation is small.

Large parts of the United States suffered from extreme droughts in 1930 and 1934. During these periods the flow of many streams in areas having underground reservoirs of small capacity decreased greatly or the



Graph of the fluctuation of artesian head in the Atlantic City 800-foot sand, as recorded in the Longport observation well, showing that the head fluctuates with pumpage rather than with precipitation.

streams became completely dry, and public supplies that depended on the natural flow of these streams were severely depleted. On the other hand, streams supplied with water from underground reservoirs with large holdover capacities were affected much less by the droughts, and the municipalities that obtain their water supplies from these streams had few acute water shortages. The Loup River in central Nebraska, which is fed chiefly by ground-water percolation from a large area of sand hills, continued to have a large flow throughout the summer of 1934. At the same time the Nemaha River, in southeastern Nebraska, was reduced to a rivulet and finally became dry because of the relatively small holdover capacity of the water-bearing formations on its drainage basin. In areas where the storage capacities of the underground reservoirs are small, towns should construct reservoirs to impound surface water for their public supplies because it is to be expected that the underground reservoirs will be greatly depleted during periods of subnormal precipitation.

Inasmuch as the flows of streams, especially during periods with small precipitation, are related to the water levels in the underground reservoirs it is possible to predict to some extent the low summer flows from the position of the ground-water levels in the spring. It is advisable for cities and villages that utilize stream flow for their water supplies to periodically measure the water levels in observation wells on the drainage basins of the streams in order to forecast the discharge of the streams at critical periods. This method of investigation is being utilized by the U. S. Geological Survey and also by power companies that are interested in the discharge of streams.

Effects of Pumpage

The United States Geological Survey has for years collected records of water level fluctuations in many areas of heavy ground-water withdrawals through wells. These records indicate that the ground-water level of most reservoirs and hence the ground-water storage in the reservoirs fluctuate continually. In general the major fluctuations have been found to be directly related to the amount of precipitation and to changes in the rates of withdrawal. Over a period of years the water level of an underground reservoir may show successive annual declines caused by less than normal recharge from precipitation. Such declines may not indicate a permanent depletion of supply or a future failure but only indicate a part of a major fluctuation. The water level in such instances may be expected to rise again with a recurring series of wet years.

There may, however, be a withdrawal of ground water for public supplies in excess of the normal rate of replenishment, and the water level may suffer net declines year after year. If the storage capacity of the underground reservoir is large this excessive rate of withdrawal may not be apparent for many years without careful observation and by that time the storage capacity may be seriously depleted and the permanency of the supply impaired. The accompanying diagram shows the fluctuation of the water level in an unused observation well in the so-called 800-foot sand at Atlantic City, the pumpage from this formation in the region, and the accumulative departure from normal precipitation in the southern interior of New Jersey since January 1, 1924. It will be noticed that increased pumpage caused the water level to decline each year from 1924 to 1929 when the precipitation was only slightly less than normal. Since 1929 the water level has risen because of the decreased draft on the underground reservoir resulting from the business depression even though the precipitation was considerably less than normal.

Many cities and villages that derive their public water supplies from wells do not collect adequate information regarding the fluctuation of the ground-water levels and the changes in storage capacity of the ground-water reservoirs from which they draw their supplies. Nor do many cities know the areal extent and water-holding capacities of the water-bearing formations from which their public supply is drawn or the amount of water being pumped from them. Consequently such communities know only in a general way the effect of their withdrawals on the underground reservoirs and depletion of the ground-water supplies may be noticed only by marked decreases in the yields of the wells. The U. S. Geological Survey has urged cities and villages that derive their water supplies from wells to maintain systematic programs of measurements on the water levels in observation wells and to keep detailed records of the amount of water pumped so that excessive withdrawals from the underground reservoirs may be detected and proper remedies effected. In all cases, records of water level and pumpage should be kept for future aid in determining the proper development of the supplies.

Aedes Aegypti Breed in Catch Basins

W. V. King, Ph.D.
United States Bureau of Entomology

IN connection with the dengue fever control campaigns throughout the State, the question has arisen as to the importance of the storm-sewer catch basins in the production of the dengue fever mosquito. A hasty perusal of the available literature did not disclose any specific information on the subject, and an examination of a number of these receptacles in one section of the City of Orlando has recently been made by Mr. McNeel and the writer. Much more aegypti breeding was found than had been anticipated. Out of 20 basins in which dippings were made, larvae and pupae of this species were found in 10, and in one or two where larvae were not obtained, adults were noticed on the walls or flying about. In the basins containing larvae, the number taken varied from a few to several hundred each. Since the larvae of this species have the habit of dropping to the bottom of the water as soon as disturbed, their collection in such locations is more or less uncertain, particularly where the water is deep, and the taking of even a few under these conditions is usually indicative of much heavier breeding.

The catch basins examined were for the most part about three feet long by two and a half feet wide and were lined with bricks. All of them contained water, varying in depth from a few inches to more than two feet, depending upon the amount of accumulated dirt and trash, and varying also as to the state of pollution. Practically all of them, of course, contained hundreds of culex larvae, most of which were the common house mosquito, culex quinquefasciatus.

Because catch basins have been relegated more or less to the doubtful class of aegypti breeding places they have undoubtedly been slighted or even entirely overlooked in the early part of the control work. The above results, however, would indicate that they should be regarded as of primary importance and handled accordingly.

Charles C. Agar

Possibilities in Chemical Treatment of Sewage

By Charles C. Agar

Assistant Sanitary Engineer, New York State Department of Health

In this article as written by Mr. Agar he gave, as an introduction to the main theme, an excellent statement of the progress made in chemical treatment during the past forty years, with an explanation of why it was temporarily abandoned—the large amount of chemicals required, inefficient chemical feeding and mixing devices, lack of scientific control methods, quantity of sludge produced and laborious and disagreeable methods of handling it, and high operating costs—and how these disadvantages have been overcome. This subject has already been discussed in two or three recent articles in PUBLIC WORKS, *and because of the limitations of space it seems necessary to omit this introductory matter.*

THERE are many fields for the use of chemical treatment methods. An outline of these fields together with a few examples of operating or proposed plants, will illustrate some of the possibilities of such processes.

There are some localities where chemical coagulation and sedimentation of sewage without subsequent treatment will satisfy the demands of the receiving watercourse and prevent nuisance conditions therein. Where this is not sufficient, filtration of the chemically treated effluent provides a treatment superior to sedimentation alone. The plant at Dearborn, Mich., in which ferric salts and lime are the principal reagents, may be cited as an example of chemical treatment followed by filtration. A similar plant is now under construction at Perth Amboy, N. J.

The greatest field for the use of chemicals as sewage coagulants at the present time appears to be where there are seasonable demands for a more complete treatment than is possible with plain sedimentation. There are a large number of installations where secondary devices could be dispensed with during the winter season without creating health hazards or nuisance conditions if it were not for the fact that continuous operation of biological processes is usually necessary to maintain the efficiency of the units needed during the summer season. In some of these instances chemical treatment during the summer season could fulfill all necessary requirements.

The new Shades Valley plant at Birmingham, Ala., is being operated as a primary treatment plant during the summer months or as occasion demands. Chlorinated copperas is used as the coagulant and the results of six months' operation have indicated that treatment comparable with biological secondary treatment may be obtained. Among proposed plants which will be operated in a similar manner, i.e. during the summer season, may be mentioned the 35 m.g.d. plant for the Coney Island section of Brooklyn and the plant at Freeport, Long Island. At the Brooklyn plant, it is proposed to use ferric sulphate and lime together with chlorine as the chemical coagulants. The sludge will be digested in heated tanks and it is expected that the gas produced will be sufficient to supply all power requirements of the plant. At the Freeport plant arrangements have been made to use chlorine and ferric chloride as the chemical precipitants.

Recent experimental work at Liberty, N. Y., has indicated that chemical treatment may solve a seasonal load problem at the sewage plant. In this case chlorine, copperas, and lime appeared to be the most economical chemicals to use, although other commercial iron salts have given excellent results in laboratory work. The results of further plant-scale work will be awaited with interest.

Chemical treatment may also afford a satisfactory solution of the treatment problem where industrial wastes constitute a large proportion of the sewage flow. Many wastes, such as those from canneries, tanneries, textile plants and allied industries, do not lend themselves readily to biological treatment. Under such conditions the use of chemicals offers a practical means of providing treatment, either alone or as a preliminary to biological methods. Chemical treatment has been recommended for the metropolitan area around Providence, R. I., where industrial wastes will predominate in the sewage to be treated.

Another field for chemical treatment may be found in those localities where extreme variations in the volume of sewage flow occur. In such instances the cost of the large biological units necessary to handle the peak loads may be prohibitive. Chemical treatment can be expected to provide the flexibility in operation needed.

In the field of strictly industrial waste treatment, chemicals have been applied successfully in solving many of the problems. The plant of the Quaker Maid Company at Brockport, N. Y., has used copperas and lime effectively in treating cannery wastes.

As an aid to existing biological treatment plants, chemicals have been shown to have real value. Pre-treatment of the raw sewage with a commercial ferric sulphate has been used to reduce the load on the trickling filters at Plainfield, N. J., during the summer season. This coagulant is also used to clarify the trickling filter effluent at this plant and therefore serves to "polish off" the effluent of a biological plant, emphasizing the possible advantage accruing from the use of chemicals to improve the effluent of existing trickling filters and activated sludge plants.

There are many beneficial effects of chemicals which are incidental to their use as chemical coagulants or in

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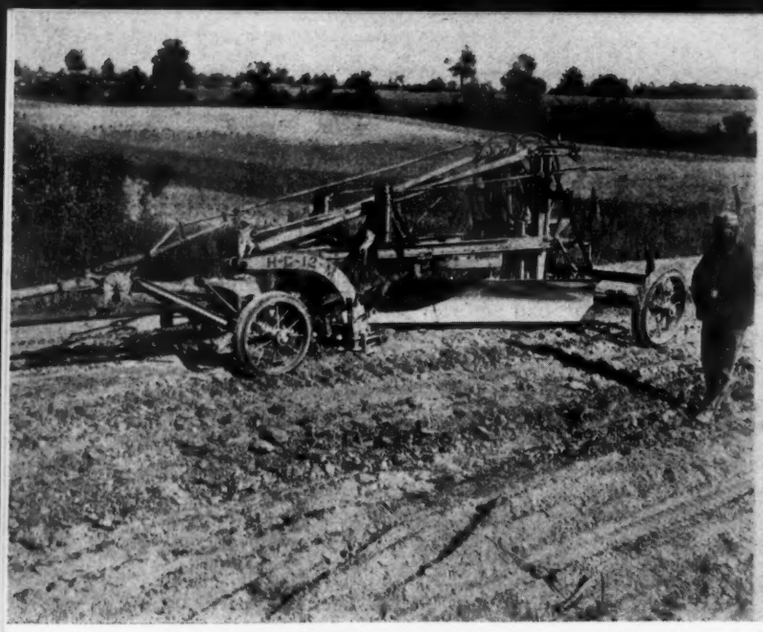
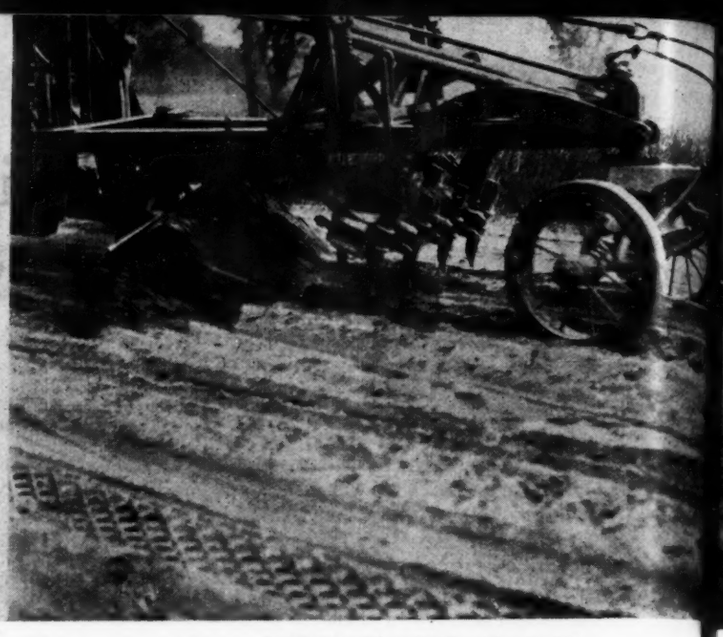


1. Scarifying old surface



2. Mixing clay and old road material

What Can Be Done With Our Two Million Miles of Rural Roads

A discussion of some considerations bearing on the economical improvement of our rural roads to serve modern traffic

MORE than 2,000,000 miles of rural road is unimproved. On much of this mileage, surfacing is not economically justified, but there is a considerable mileage which should be surfaced and the extent to which this is done will depend on the cost.

The importance of the subject of improving this two million miles of road more than justifies the devotion of the entire February issue of "Public Roads" (official publication of the Bureau of Public Roads) to an article on "Soil Road Surfaces," by C. A. Hogentogler, senior highway engineer of the Bureau. In this he reviews the history of the scientific development of soil road improvement, bringing it up to date with the important progress made during the past year or two. From this article we excerpt a few paragraphs which give fundamental principles and latest conclusions.

Only a small percentage of natural soils are of good quality for road surfacing. Even in Georgia, where soil conditions are particularly favorable, soils of the best quality are more the exception than the rule. Admixtures and chemical treatments are most often used to give low-grade materials those qualities naturally present in class A topsoils as a result of long cultivation and weathering and in well-graded gravels as a result of their composition. The admixtures and treatments have the additional advantage that they avoid the necessity of a dust-producing mulch surface.

Substantial progress has been made in the design of soil mixtures, and in the use of bituminous surface treatments and stabilization of the moisture content by means of treatment with deliquescent substances.

Water attracted by the adsorptive affinity of soil particles for moisture cannot enter and soften the soil mass when the particles are covered with moisture films and the soil is compacted to maximum density at optimum moisture content. Under these conditions the tendency to expand and lose stability in the presence of moisture may be eliminated from highly plastic soils when protected by surface treatment. (Densification will not be effective with soils in which the tendency to expand is due to elastic rebound such as those containing mica.)

Field experimentation in the use of chemical admixtures which change the character of the soil include the use of portland cement, bituminous emulsions, and treatment with sodium silicate and calcium chloride in combination to produce calcium silicate precipitate.

Several sections of soil road stabilized with cement and given a bituminous surface treatment were constructed by the South Carolina State Highway Department during 1934. A bituminous emulsion was mixed with the soil in constructing an airport runway in Baltimore, Md. The use of the silicate-chloride method of treatment has been confined largely to the stabilization of soil supporting buildings and other structures.

The stability furnished by compaction of soils at optimum moisture content suggests that vastly greater benefits may be expected when the interfacial colloidal films are stabilized by proper use of bitumen, portland cement, and the ions of sodium, potassium, and calcium.

New developments can be expected as progress is made in this vast and but little explored field. The materials being investigated are low in cost and widely different in character. They are subjected to varying weather conditions and traffic loads. The results obtained should be evaluated on the basis of the benefit rendered by the stabilizing procedure in comparison with its cost.

3. Removing large stone with rake

4. Spreading the chemical

Experience with soils indicates that they are stable only when they contain constituents which produce the following:

1. A certain total of seating and embedment stability together with the density required to resist traffic pressures and impacts.

2. An internal bond developed from interlocking grains and capillary moisture forces sufficient to cause the coarser sizes of sand and the coarse aggregate to have high stability during wet weather when the cohesion furnished by the clay may be greatly reduced.

3. Sufficient cohesion in the binder to cement the sand and silt when in a dry or almost dry condition and thus maintain the integrity of the surface during dry weather.

4. A surface which maintains constant volume, that is, there should not be so much clay that its expansion by water will break the seating and embedment bond of the granular particles.

5. Rapid evaporation to prevent the accumulation of capillary moisture from the subgrade beneath and active percolation to dispose of the rain water which may collect on the roadway in spite of efforts to maintain a smooth surface for the prompt removal of water.

(Discussion of No. 5, about which there is a difference of opinion, will appear next month.)

Absence of moisture films from soil road surfaces causes dust and raveling; too much moisture causes rutting. The drier a road surface becomes as a result of evaporation, the wetter a rain will make it. This is because extreme dryness causes small cracks and fissures to form in the clay binder through which rain water may enter and soften the interior of the road surface. Fissures do not form in damp surfaces of properly selected constituents and water will be shed from the surface without injurious effect.

Dampness of surface is desirable for another reason. All types of topsoil, gravel, traffic-bound and even water-bound macadam road surfaces acquire their final consolidation through compaction by traffic during what might be termed a period of seasoning following construction. When the surface is dry during this period the mineral binder powders under traffic and permits raveling of the surface, which requires extensive patching of the macadams and maintenance by means of mulch on the other types.

If such surfaces can be maintained in a damp or slightly moist state the moisture films in the minute pores of the binder will prevent the separation of the granular particles and the shocks and blows produced by traffic become effective in gradually wedging the granular fragments into close association. The cohesion increases as the pores in the binder become smaller and finally the coarse aggregate, the sand, the filler, and the binder are formed into a stable, durable road structure. Calcium chloride is the principal chemical used in this type of stabilization, although common salt has been used to a limited extent in experimental sections.

The writer used calcium chloride as a dust layer on short sections of macadam streets in Pennsylvania about 1912. The value of this substance as a dust layer for gravel roads was quite generally recognized by 1916.

Effect of Evaporation

The Highway Research Board's investigation disclosed, among other things, that calcium chloride placed upon the surface retards the evaporation of soil moisture and that the moisture film cohesion furnished by calcium chloride is more stable than that furnished by plain water. It also showed that during periods of low rainfall and high temperatures the sections treated with calcium chloride have the higher moisture content and that calcium chloride is retained best in compacted and undisturbed surfaces.

The primary reason for the decrease in rate of evaporation is the low vapor pressure of the calcium chloride. A layer of the solution on the surface of the soil particle may be conceived of as an effective semi-permeable blanket through which the moisture from the soil has difficulty in reaching the surface where evaporation can occur.

The hygroscopic property of calcium chloride causes absorption of moisture from the air during periods of high humidity and also slows up the rate at which soils lose moisture.

The high density attained during compaction by traffic is indicated by dry weights of as much as 150 pounds per cubic foot, which have been observed for wearing courses treated with calcium chloride and common salt. Retention of the material in the highly compacted state accounts for the beneficial action of the chemical upon the preservation of the road material.

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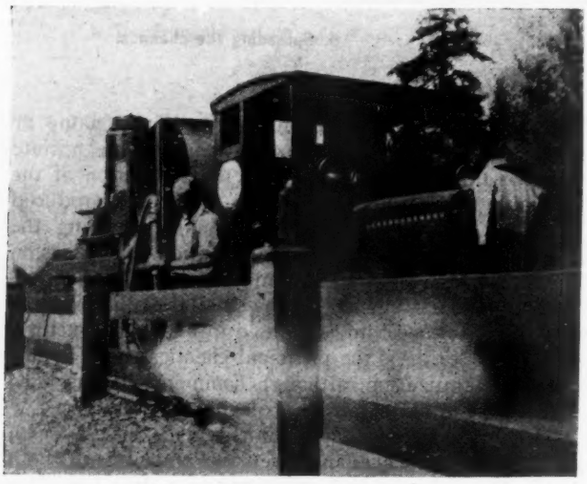
Reducing Highway Maintenance Costs in Washington

The necessity of maintaining well painted highway guard rails, bridges, abutments and the center lines of roadways in the interest of safety represents one of the considerable items of State Highway maintenance expense. The Highway Department of the State of Washington has produced some interesting savings figures in their effort to reduce materially maintenance costs on these safety devices.

In this State, painting costs of highway guard rails alone, including labor, brushes and material, amounts



Cleaning Guard Rail

to 5½ cents per foot, due to the fact that traffic dust and dirt so quickly obscures the painted surface of guard rails. It was therefore decided to do some experimental work with various methods of cleaning in order to reclaim the safety value of these rails for night driving.

This experimental work resulted in the adoption of the Vapor Spray method of cleaning as produced by "Hypressure Jenny." The cost of cleaning by this method, including a depreciation reserve that will allow purchase of new equipment every five years, water, cleaning compounds and labor, amounts to 1⅝ cents per foot. A close check shows that at least one painting operation is saved through this method of cleaning.

The illustration shows the cleaning operation in progress. The equipment, consisting of a Hypressure Jenny Cleaner, 600-barrel water tank, motor generator and cleaning compound barrels, is mounted on a Washington State Highway truck. Two outlet vapor lines are piped from the cleaner; one extending to the front of the truck; the other to the rear. To each of these lines is attached a 25 foot length of hose with a single gun and a 2 inch flat nozzle. The man at the front of the truck with control valve on the gun half open, cleans the posts and keeps the guard rail thoroughly wet. The man at the rear using full pressure cleans the rail thoroughly.

It is estimated that on guard rails in use on the Pacific Highway alone, a savings of approximately $9,000 yearly will be effected. In addition to the cleaning of guard rails, the Department uses this equipment to clean bridges, abutments, over-passes and center lines as well as construction equipment.

The equipment shown is manufactured by the Homestead Valve Mfg. Co., Coraopolis, Pa.

Cast Iron Diffusion Outlet at Cincinnati

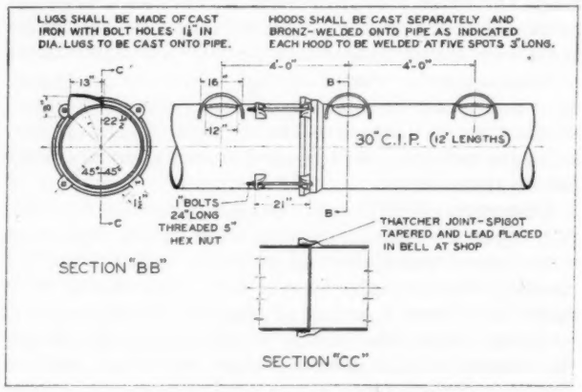
A sewer outlet has been laid recently by Hamilton County, Ohio, which is unusual in that it is provided with special diffusion outlets in the cast iron pipe. The sewer is known as the Muddy Creek outfall sewer, and construction was in charge of J. S. Raffety, sanitary engineer of Hamilton County, Reno Runck being contractor.

The sewer is 30 in. in diameter and extends 248 ft. into the river. This outfall is cast iron pipe, and each of the four outer lengths is provided with three holes 12 in. in diameter cored through the wall of the pipe. A hood 13 in. long by 8 in. high was welded over each hole facing at right angles to the axis. These twelve holes were set 22½ degrees down stream from the top of the pipe, with the hoods pointing down stream and thus creating a suction to draw the sewage from the holes and also protecting the holes from stoppage.

As the river bed under these diffusion pipes was rock, they could not be supported on piles in the customary way, but were laid on the bottom and tied down by anchors formed by placing about 1.5 cu. yd of concrete on each side of the pipe and embedding in each mass one end of a chain that passed over the pipe.

The joints of the outfall were modified Thatcher—the bells were standard and the spigot ends machined to a very flat taper. The joint was made up in the shop and the spigot then slipped out, leaving the lead in the bell; to be replaced when the pipe was laid, the lead then being calked. To hold the pipes together, lugs were cast onto both ends of the pipe and bolts passed through each pair and tightened up when the pipe had been laid but before the lead was calked. (In the regular Thatcher joint a bell ring and a follower ring, equipped with lugs, are bolted onto the pipe before laying.)

The diffusion openings were designed by the county sanitary engineer's office and the staff of the U. S. Pipe and Foundry Co., which furnished the pipe.



Details of cast iron diffuser pipe

The Editor's Page

Health Insurance and Social Security

Some municipalities fail to provide themselves with the necessities of safe water supply, sewerage, refuse disposal and sewage treatment because of financial restrictions, priority given to other competitive municipal functions, or simply because they are fundamentally unprogressive—none of them good reasons.

It is most important right now to have these safeguards to health. Disease is always costly, and under present conditions most of us can not afford to be sick. The average case of typhoid fever keeps the victim from working for a period of 57 days, and in one case out of ten he fails to recover. In addition to the loss of 57 days' pay, there are costs for medical service to be met and perhaps hospital charges. In fact, from the viewpoint of public welfare every typhoid fever case ought to be hospitalized to protect the community. If death follows, there are funeral expenses, and the family loses its wage earner. Even if it is not the earner himself who is stricken, but one of his family, the sickness costs are serious to him from the financial viewpoint, and some expenditure to avoid them is as financially justifiable as is fire insurance.

It costs a community less today to provide these essential protections to health than ever before. Improved methods of sewage treatment and greater knowledge and skill in the control of water quality permit of these essentials at a lower first cost and with less annual operating charges. There is no cheaper way to health insurance and social security.

Should State or Federal health insurance be adopted, the economy of securing and efficiently operating these necessities would soon be brought home to the tax payers. A comparison of the balance sheets between the cost of health insurance and that of these health safeguards in various states would, we are convinced, show greatly in favor of those adopting the most progressive sanitation programs.

Another Revival in Sewage Treatment

With the increasing willingness of sanitary engineers to recognize possibilities in methods of sewage disposal which do not rely upon bacterial action in tanks and filters, there has been correspondingly more attention paid to well-known methods which have for years been overlooked to a very great extent, and study is being made of these in the light of increased knowledge of the physical, chemical and other principles involved in their performance. An outstanding example is the use of chemical treatment.

An article in this issue explains some of the advantages of irrigation—the oldest method (other than dilution) employed for disposing of water-carried household wastes. The wider use of this method would help to solve, for some localities, problems raised by the drought of recent years. It would seem to be subject to limitations and demand more scientific treatment in both designing and operating than it received 25 to 50 years ago. Large amounts of any of several kinds of trade wastes would render this disposal of sewage difficult; crops must be selected which demand or will tolerate large quantities of water throughout the entire season; and facilities must exist or be provided which will permit other disposition of a part, at least, of surplus sewage when this becomes excessive in volume or more than the crops will tolerate.

These are some of the difficulties which caused irrigation to be abandoned in all except a few particularly favorable localities. We believe that they can be solved in many cases by recently acquired technical knowledge, skill and ingenuity, and that this may be added to the methods which the sanitary engineer can consider in his search for the best scheme for a given case.

Pavement Construction With Relief Labor

A large mid-west city has found relatively few disadvantages in constructing pavements with relief labor, this fact being reflected in the unit costs, which are stated as being less for force-account work than for contract work. The paving experiences of this city are described on another page of this issue.

Street and highway work offer exceptional opportunities for unemployment relief, whether the work be done by force account or by contract. Men can be employed to the advantage of the community; the cost of keeping these men at work need not be much greater than the cost of direct relief for which the community receives no return whatever; and if good engineering, good materials and proper equipment are used, the result will be a sound structure of enduring benefit.

Most of our city, county and state engineers are too well-trained and too sensible not to realize the necessity for combining sound engineering and construction methods with relief labor if a good job is to be obtained. No one can build good roads with labor, picks and shovels only. Under the pressure of the times, this method was tried out a couple of years back, mostly at the insistence of non-engineering officials unfamiliar with the elements of construction work. Many of these officials have since been retired to private life by voters who differentiated between really constructive and valuable work and "made" work.

The past two years have greatly enhanced the importance of the municipal engineer in unemployment relief work, and this very fact guarantees that the vast sums now being appropriated for such work will be well spent. These billions must pass through engineering hands, and there are no organizations available for spending the bulk of this money other than our state, county and city engineering forces. Nearly two and one half billions of dollars are ear-marked in the bill now before Congress for expenditures for or in connection with governmental units. The fact that it will be expended very largely under the direction of these engineers is encouraging. We venture the belief that their judgment, training and honesty assure that it will be spent well, and with advantage to the community in which it is spent.

Portion of completed road, showing low retaining wall between highway and railway, and waste dumped across the track into the river

Many Difficulties Encountered in Iowa Highway Project

By E. T. Korf
Office Engineer, Iowa State Highway Com'n.

ALTHOUGH most of the state of Iowa is broad rolling prairie, there is a small area in the northeastern part where the topography presents some rather difficult problems in highway location. One of these problems occurred in the improvement of 6.27 miles of State Highway No. 13, running along the west bank of the Mississippi river for about 2.75 miles from Marquette and then climbing over a divide.

In the early days of the state this was a wagon trail with no definitely established right-of-way. Later the C. M. & St. P. railway followed the same route for a line from Dubuque to Minneapolis, laying its track between the trail and the river, also with no established right of way. Limestone bluffs occur along the river, at places rising vertically to a height of several hundred feet, and the railroad crowded the wagon trail into these, leaving barely width enough for a single vehicle.

When the State Highway Commission decided to build a modern highway along the route of this old road it encountered numerous difficulties. First of all, insufficient space existed between the roadbed of the railway and the rock bluffs to permit the building of a highway of the required width without encroaching upon the property claimed by the railway company. After months of negotiations an agreement was reached whereby the Highway Commission was to build a two-traffic-lane highway the grade of which was to be held within the limits of one foot and four feet above the grade of the railway. The distance from center line of the rails to the center line of the highway was to be 28 feet, and a clear distance of 14 feet was to be maintained between the highway fill and the track center line, in order that a ditch might be maintained between the two fills. All drainage structures built for the highway were to be continued under the grade of the railway; all excavated material which was not needed for building the road was to be wasted between the railway grade and the bank of the river in such a manner as to provide for a possible future track, and all telegraph wires were to be moved to a temporary new location and later replaced along the railway. The work to be done without interruption of railway traffic and all expense to be borne by the state.

With two twelve-foot traffic lanes and with the grade of the highway from one to four feet above the grade of the railway, obviously a ditch could not be maintained between the two fills if they were built with the usual side slopes, and it was found necessary to design a retaining wall between the embankments of the railway and the highway for nearly the entire distance, containing approximately 4000 cubic yards of hand-placed dry masonry. Fortunately no drainage structures were needed other than box and pipe culverts. The grades were very light and no especially difficult problems were encountered other than getting into agreement with the railway company.

After leaving the bank of the Mississippi and the line of the railway (which occurred at approximately the point where the Yellow river was crossed, roughly 2.75 miles from the starting point), entirely different difficulties were encountered. In order to get a suitable alignment and still keep the grades within the necessary limits, it was found necessary, even after surveying a number of possible routes, to rise from elevation of 642 to elevation 1132 in a distance of 1.6 miles, with the grade at one place reaching a maximum of 7.15 per cent for a distance of 4600 feet, which is 1.15 per cent above the standard maximum grade for Iowa.

The contract for the grading work was let to Nolan Bros. Inc., of Minneapolis, at a total contract price of $115,639.08, and included 65,000 cubic yards of earth, 85,000 cubic yards of rock, and 253,000 cubic yards of unclassified excavation. The contract for clearing and grubbing approximately 10,000 trees 3 to 36 inches in diameter was let to Griffis Bros. Construction Co., of Minneapolis for $7,097.02. Contract for a 150-ft. truss bridge over the Yellow river with four 40-ft. approach spans, together with a smaller I.B. bridge and the sixteen culverts north of the Yellow river, was let to the Clinton Bridge Works of Clinton, Iowa. Seventeen box and pipe culverts south of the Yellow river on the part of the work adjacent to the railway, were let to C. E. Schroeder of McGregor, Iowa; and two box culverts and one temporary wood trestle to Thor Fisko of Garber, Iowa. The total contract price for the bridge and culvert work let to these three firms amounted to $45,889.01.

The right of way was covered with such a dense mass of brush and trees that it was necessary to remove these before the other work started; also to complete the grading on all of that portion of the highway south of the Yellow river before the culverts could be built.

The telegraph lines along the railway were temporarily replaced by a five-pair rubber-covered cable carried by means of a steel messenger of No. 4 wire which was fastened to trees high up on the bluffs where it would be in no danger from the blasting of stumps and rock during the progress of the work.

The contract for clearing and grubbing of the trees from the right of way was the largest single contract ever let by the Iowa Highway Commission for work of this kind. The trees when cut were turned over to the property owners from whom the right of way had been purchased; or, if they did not care for them, to the unemployed people of the town of Marquette, arrangements having been made to have this wood delivered without charge to the people.

The grading contractor's equipment consisted of three gas shovels and the necessary number of cat wagons, trucks, etc. Temporary planked crossings were built at convenient intervals across the railway track and flagmen were stationed at these crossings. All trains moved on regular schedule but operated under slow order in the vicinity of the work.

Work was scarcely under way when the War Department served notice on the Highway Commission that the wasted excavated materials could not be dumped between the railway track and the river as it would encroach upon the waterway. As this was the only place where the excess earth and rock could be wasted economically, and as the agreement between the railway company and the Highway Commission called for wasting this material in a somewhat uniform fill adjacent to the present railway dump, this notice threatened to prove a real barrier to the building of the highway. However, after extended negotiations

It looked pretty, but it wasn't a road for modern travel

Completed road. Note hand-laid rock wall 14 feet from center line of railroad. Later a guard rail was built in an almost unbroken line for the entire 2.75 miles

with the army engineers stationed in St. Paul and upon the agreement of the Highway Commission to remove several thousand yards of rock which had already been dumped into the edge of the water, the War Department agreed to allow the work to proceed provided that the waste bank be kept within certain well defined lines and that the outer slope of this bank be riprapped so as to present a neat appearance and not offer too much resistance to the flow of the water in the river.

After once getting under way, the grading work proceeded without any unusual features. As the work progressed it became apparent that the decision to locate the center of the highway only twenty-eight feet from the center of the railway track, and to build over two miles of retaining wall between the two fills rather than to move nearer the rock bluffs, had been a wise one. In many places for considerable distances the excavation consisted almost wholly of talus slopes which, when removed, left a sheer rock wall standing with barely enough clearance for the highway. In fact, so little solid rock was encountered within the limits of the standard road cross-sections that in places it was necessary to go outside these cross-sections to get suitable rock for building the retaining wall.

The field party encountered some difficulty in taking the final cross sections after the grading work had been completed. In many places it was impossible for a rodman to reach the upper slope of the cross section, and even had he been able to reach this point the side of the bluffs afforded no place for the instrument man to set up his level. This difficulty was finally over-

come by the use of a 32-foot extension ladder which was placed against the face of the rock. The chainman then ascended this ladder with the tape, which he held at the intersection of the back slope and the original surface. The transit man then set up over the center line station and read the vertical angle to the end of the tape and measured the slope distance. At such places as the ladder would not reach, the tape was fastened to the end of a long pole and in that way held on the desired point.

The majority of the culverts which extended under the railway were of the reinforced concrete pipe type. The railroad rails and ties were removed and the pipes laid in a trench and properly imbedded, after which they were covered and the rails and ties replaced. By timing the laying of these pipes with the train schedule, it was possible to complete the work without interrupting train traffic. The portion of these culverts which was built under the highway grade consisted of reinforced concrete pipe made to conform to the standard specifications of the State Highway Commission. The pipe under the railway was built by and furnished in the yards at Marquette by said company but were paid for by the state. No openings were provided in these culverts for the entrance of any surface water which might collect in the side ditch between the two fills.

Where reinforced concrete box culverts were built under the two fills, two separate structures were built end to end with the flow lines at the same elevation at the junction point. This method of construction provided an opening for the entrance of surface water from the side ditch between the highway and railway fills. In building one of the larger box culverts under the railway it was found that sufficient water way and fall to the river bank could not be obtained and it was necessary to raise the track a distance of four feet at this point. In order to avoid interruption to train traffic, piles were driven through the railway fill and a temporary wood span built to carry the railway over the culvert location. The culvert excavation was then made under this temporary trestle, the forms built, and concrete poured without interference with train schedules. After the concrete was properly set up the temporary span was removed and the fill placed over the culvert.

During the construction of all culverts which were built through the railway fill, an inspector furnished by the railway, but paid by the state, was on the job. The actual work of taking up and replacing the track was done by the railway section crew, but the cost of the work was borne by the state.

The building of the 150x20 foot high truss with the four 50x20 I-beam approach spans presented some rather unusual foundation problems for highway bridges in this state. Test holes bored to a depth of 54 feet below the bed of the stream at the site of the main river piers reached clayey sand and gravel. The footings for the two piers of the main span were carried 6 feet below the bed of the stream and placed on 40-foot wood piles driven to a bearing of approximately twenty tons. The north abutment consisted of what might be called a concrete cap deslgned to rest on 66-foot steel piles driven to a depth of 36 feet below the stream bed, where a test hole had showed a firm compact layer of coarse gravel and it was thought that adequate bearing would be obtained. However, when these piles were driven it was found that the bearing at this depth was inadequate and it was necessary to splice an additional 40-foot length to each pile in order to obtain the designed bearing of eighteen tons. This gave these piles a length of 106 ft. with the bottoms 76 feet below the bed of the stream, a record depth for piling under a highway bridge in the state of Iowa.

After the completion of the bridging and grading, the roadbed was surfaced with crushed rock, obtained from the limestone ledges in the vicinity of the project, applied at the rate of 1000 cu. yds. per mile. This work was done under the supervision of the State Maintenance Department. The labor used in producing the stone in the quarry, also the trucks and drivers for hauling, were obtained from the list of unemployed in the two counties where the project was located.

The final cost of the various classes of the work on the project were as follows:

Grading Work

Final estimate on clearing and grubbing contract	$ 7,766.65
Final estimate on 65,016 cu. yds. earth excavation @ 12c	7,801.92
Final estimate on 272,655 cu. yds. unclassified excavation @ 26c	70,890.30
Final estimate on 91,533 cu. yds. rock @ 38c	34,782.54
Final estimate on other contract items and extra work	19,852.68
Final estimate on three bridge contracts	49,972.46
Paid to Ry. Co., for work and materials	16,304.80
Cost of stone surfacing	7,920.03
Right of way and other miscellaneous costs	10,307.42
Total cost of project	$225,598.80

This total cost averages approximately $36,000 per mile, making this one of the most expensive unpaved highways ever built by the state outside the incorporated limits of cities or towns. However, the general feeling is that the money was well spent, as this highway fills a long-felt need in the community which it serves.

This highway project was carried out under the general supervision of F. H. Mann, assistant chief engineer for the Iowa State Highway Commission, with F. B. Thillen, resident engineer, in direct charge of the construction work.

Ohio Sewage Treatment Campaign Aided by P.W.A. Funds

P. W. A. has been instrumental in furthering the campaign for improved sewage disposal by the Ohio State Board of Health. In the period of a little over a year that P. W. A. has been functioning, a number of sewage treatment projects have been inaugurated and today 11 new plants are under contract. With the completion of these plants a total of 26 new plants will have been placed in operation since 1929.

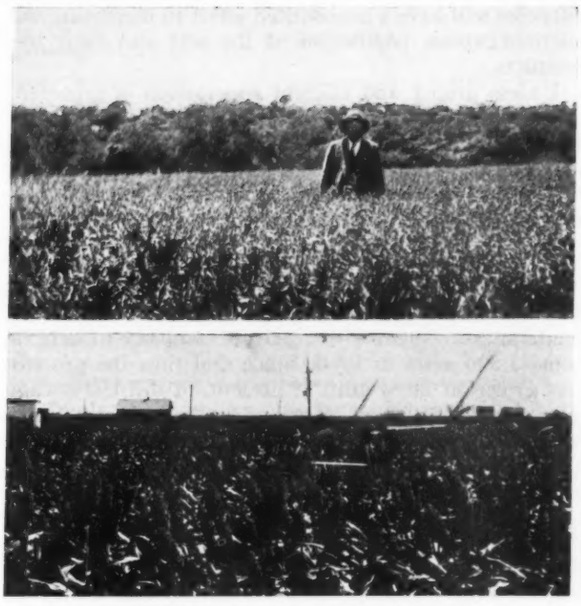
In addition to the foregoing, three projects for new sewage treatment plants have been approved by P. W. A. and await only the completion of engineering and financial details. These projects are at Byesville (pop. 2,638), Wauseon (pop. 2,889) and Willard (pop. 4,514). In the case of Willard, a special election was held January 22, 1935, on the question of issuing bonds totaling $75,000 to pay part of the cost, the remaining cost, less the Federal grant, to be financed by mortgage revenue bonds in the amount of $62,000. The bond issue was approved by a vote of 767 yes to 284 no.

With the contemplated inauguration of a new works relief program by the Federal government it is most likely that a number of other Ohio municipalities will embrace the opportunity to construct much-needed sewage treatment projects.

From *Ohio Health News* for Feb. 1st.

Sewage Irrigation in Texas

By Earl H. Goodwin
Sewage Consultant for Texas State Board of Health



Top—Oats on sewer farm, City of Kerrville
Bottom—Feed grown on sub-irrigated land; note greater height of row directly over tile. Tile was laid in rows 9 feet apart—not close enough to give uniform distribution of moisture.

FOR several years irrigation has been used in Texas as a satisfactory method of secondary treatment of sewage effluent. The two types employed are subsurface and surface irrigation. The subsurface method is used by only a few cities and is essentially the disposing of the effluent through an underground tile system. The important advantages of this method are ease of cultivation, no loss of effluent from free evaporation, and the spreading of the liquid over a larger area. These factors, however, do not, in our opinion, justify the additional cost.

Among the surface methods of conveying sewage effluent are: (1) The spray system, which is sometimes used on small scale in the culture of flowers and gardens. (2) The border method, which is used when the field can easily be divided into strips or beds. (3) The furrow method, which is used when row crops are to be irrigated. The majority of cities employ this third method, since it seems to best suit their needs.

Requisites for Successful Irrigation

Consideration should be given to the following points if this method of disposal is to be employed successfully:

Soil has proven to be a good purifier of water carrying organic matter. The porous sandy soils seem most acceptable for irrigation, since the circulation of air and water must be as free as possible. The chemical nature of the soil and the substratum, clay, gravel, sand, etc., are also important factors in the land treatment of sewage.

The most satisfactory effluents are those which have been pre-treated by sedimentation or other methods to reduce settleable solids by at least 50% and preferably about 80%. Extra care must be taken to prevent oil and grease from passing on to the land, since they will hinder crop growth. Effluents containing acids and alkalies are not used, since they tend to destroy the fertility of the soil. It has been estimated that every persons wastes annually eight pounds of nitrogen, three pounds of potassium, two pounds of phosphorus not including the organic matter in which these elements are parts. It is very easy to estimate, therefore, the tremendous and valuable amount of plant food now going into the rivers, etc.

The rate of application varies in Texas from 5,000 gallons per acre per day to as high as 20,000 gallons per acre per day. The amount of effluent discharged on the land is determined not only by the porosity of the soil but also by climatic conditions and the "water demand" of the crop irrigated. Heavy flooding before planting and careful watering during the growing period seem to give best results.

The land to be irrigated is usually laid off in furrows about three feet apart and the liquid applied in every furrow in an amount that can be absorbed within thirty minutes after application, since the water table should never be raised above the roots of the plant. The land is usually plowed to a depth of twelve inches at least once each year. This is done not only to promote the growth of the crops but also to prevent water-logging which might create a nuisance such as odor, fly and mosquito breeding, etc.

Since storage of the liquid in earthen holding tanks or reservoirs becomes necessary during wet weather, harvest periods and when there is an excess of effluent on hand, care should be taken that the tank is placed a sufficient distance from occupied homes to prevent odor annoyance, and that proper maintenance is assured. At least 25% of the land under cultivation should be held in reserve for application of sewage at such times as plants would suffer from additional moisture. During rainy seasons, when there is ample dilution water in the adjoining streams, the effluent may be diverted to such waterway under condition that no nuisance is created.

Some of the crops grown in Texas are grains such as maize, hegira, kaffir, corn, barley, oats and popcorn; grasses such as sudan, Rescue, Johnson grass and cane; cotton and alfalfa are also grown successfully, as are pecan, walnut, grapefruit and orange trees. Vegetables, even though cooked, should be irrigated with sewage only when a special permit is secured from the State Board of Health. Flowers such as tulips, roses, etc., are grown with excess activated sludge.

We have been informed by persons doing research work with plant diseases, that by using sewage effluent for irrigation, the soil structure and microbiological activity may be changed so as to effect a partial control of the cotton root-rot disease. Sewage effluent for irrigation

purposes will have a pronounced effect in increasing the micro-organism population of the soil and their by-products.

Unless proper and efficient supervision is provided, the success of the method may be impaired in that: (1) sewage and soil may not be properly handled. (2) crops may not be well selected and properly grown, and (3) the production and income may not be in proportion to the cost of disposal by this method.

Extent of Irrigation

The first city in Texas to employ this means of sewage disposal was San Antonio which, as far back as 1900, made an agreement with a private company to irrigate some 3,500 acres of land. Since that time the practice has grown in favor until at present, of the 450 sewage plants in Texas, about 47 are using the irrigation process as a means of treatment. There are now approximately 4,500 acres in Texas being irrigated with sewage effluent.

The size of the irrigated farms varies from one to 350 acres, with an average of about 20 acres. These farms were purchased at a value of $25 to $125 per acre, and in some instances the cities have leased farms for this purpose. Several farms are operated by the municipality and they receive all of the revenue therefrom; some farms are leased by farmers who receive the revenue for taking care of the effluent, while other cities furnish this effluent to farmers for their private use as needed. Cities report a revenue from these irrigated crops ranging from $25 per acre per year to $125 per acre per year. The cost to the city of disposing of their wastes where the effluent is furnished to private individuals varies from nothing to $10 per million gallons.

Supplementing Underground Water

Reclamation of sewage is being advocated by certain sanitarians in the West not merely for the purpose of disposing of sewage and averting of health menaces, but also for the purpose of supplementing underground water supplies. The sewage effluent from at least one western city is being spread upon the outcroppings of sand and is re-used successfully—the water table raised, and the water re-used for irrigation purposes several miles away. This is one of the most recent developments in the sewage irrigation practice and while considerable research and experiments are being carried on in this connection in some states, no definite conclusions have been officially released so far as we know. However, it seems to us that it would be well for Texas to investigate and conduct a research in this same connection.

For some time the underground water level that supplies the Winter Garden District around Carrizo Springs has been dropping. Investigation has revealed that this water sinks into the ground above Uvalde and plans are underway to build dams and divert flood water into this stratum. It has also been noted that the effluent from the Georgetown sewer plant sinks quickly out of sight, going into a like underground pool. If other strata outcroppings can be located and sewage effluent run into them, much good may be accomplished in raising the underground water levels, conserving water supplies and improving the present sanitary conditions.

Since a great portion of Texas is normally arid and most of these sections have soils especially adapted to this method of disposal, and since the drought which we have experienced in this State for the past few years has indicated to us an urgent necessity for the conservation of water, we would not only recommend but in some cases prefer the irrigation method as probably the most acceptable, feasible and economical means of sewage disposal to be used.

While the revenue from the crops does not always meet the expense of application, if the cost of secondary treatment is taken into consideration the application of this method of disposal in the arid, sandy West will many times be found the most economical one.

Sealing Akron Pavements

By R. H. Wise

District Engineer, Dept. of Public Service

During the season of 1934, six miles of Akron, Ohio, macadam paved streets were sealed with tar, and ten miles of asphalt, concrete and brick paved streets were sealed with asphalt emulsion, at an average cost of:

Single seal . . . . . $0.08 per square yard
Double seal . . . . . $0.18 per square yard

Sealing with bituminous materials is a very satisfactory method of treating all types of pavement which have cracked or checked, allowing leakage. This method not only seals and waterproofs cracked and badly worn pavements, but gives an additional wearing surface, with *non-skid properties*, thus preventing accidents.

Applying seal coat on Akron's municipal airport runways

Construction of double seal is as follows:

1. Clean pavement thoroughly.
2. Patch all deep depressions.
3. Apply from 0.25 to 0.5 gallon of bituminous material per square yard.
4. Cover with from 18 to 20 pounds of broken stone or slag chips, broom drag and roll.
5. Apply one-half gallon of bituminous material, cover with fifteen pounds of chips per square yard, broom drag and roll.

Single seal may be used on pavements which are not subject to heavy traffic.

Single seal method is similar to double seal method, using from 0.3 to 0.5 gallon of bituminous material per square yard, and 18 pounds of the chips, No. 6 size.

Bituminous materials are applied by the use of a pressure distributor. The flow or distribution is regulated by the size of spray nozzle used and the speed at which the distributor travels.

Experience has taught us that 18 to 20 pounds of broken stone or slag chips are required to cover each application of bituminous material per square yard. This material is placed in stock piles about 15 feet apart and is spread by hand. The use of a spreader is a more modern method of applying this material; however, the hand method has been used during the depression period in order to provide more hand labor. When times become more normal, we expect to use spreaders.

The broom-drag is a piece of equipment consisting of a wooden frame 7′ x 12′, with several transverse rows of fibre brooms, and is used to smooth and fill minor irregularities with broken stone or slag chips, insuring smooth surface.

The roller used is an eight-ton tandem steam roller, similar to those used by contractors on sheet asphalt.

Beginning _____ 193__
Ending _____ 193__

REPORT AND TIME SHEET OF
Marion County Highway Department

PALMYRA, _____ 193__

NAME	KIND OF WORK	T	F	S	S	M	T	W	T	F	S	S	M	T	W	Total Hours	Rate c	Am't. Due	PROJECT	Gal. Gas	Gal. Oil	Lbs. Gr'se.	Repair Costs	Sks. Cem.	Yds. Grv'l.	Lbs. St'l.	Approx. Cost
TOTALS																											

REMARKS

NOTE—All spaces necessary to make a complete report must be filled out as this will be used as a record.

W. D. COOPER, Highway Engineer Certified as Correct: _____
Foreman in Charge

How Marion County, Missouri, Handles Highway Work

By W. D. Cooper
Highway Engineer of Marion County, Mo.

MARION County, Missouri, has set up a highway department different from that of any other county in the State of Missouri, or probably in the United States. Under the Missouri law, a county is supposed to be subdivided into numerous road districts and each road district has a road overseer; the average size of road districts being about nine square miles, or the same as a rural school district. The counties have four different road taxes—the special road and bridge tax, the general road tax, the road and bridge tax and the district poll tax.

W. D. Cooper, Highway Engineer, Marion County

Marion county has an area of 420 square miles on the west bank of the Mississippi river, 100 miles north of St. Louis. Palmyra is the county seat and Hannibal (the home of Mark Twain and Admiral Coontz) is its metropolis.

When the present highway engineer (W. D. Cooper) took charge of the Marion County Highway Department January 1st, 1924, there were 62 so-called road districts in the county, 62 road overseers and almost the same number of small two-horse road graders, with no motorized equipment whatever. The assessed valuation of Marion county at that time was about $35,000,000, and, the special road and bridge tax being 2½ mills, the general road tax 1½ mills, the road and bridge tax being the interest on county depositories, and the district poll tax being $4.00 for all male citizens over 21 and under 60 years of age in rural districts, a total of $130,000 was available annually for road building; and it is safe to say that over $90,000 of this went to general overhead expenses.

Under the law it was mandatory for the county court to prorate and advance all road moneys to the various road overseers during the month of March, the road overseers to work the roads according to their own ideas, spend this money as they saw fit and make their annual settlement with the county court during the following February. Under this method the road overseers were at liberty to pay themselves at their own discretion, which naturally would account for the enormous overhead expenses.

Marion county has within its borders 719 miles of public highways; and on January 1st, 1924, approximately 120 miles of these were gravel roads and one mile was concrete road.

In February of 1924, the engineer suggested to the county court a plan, to be uniform throughout the county, whereby more of the county funds could be applied to road building than at present. He recommended that road districts be abolished, road overseers be dispensed with, horse graders junked, the county funds kept in the various banks of the country on open account and draw interest on daily balance (which at that time meant several thousand dollars per year in interest), the special road and bridge tax cut to 1½ mills, the general road tax cut to one mill and the district poll tax be eliminated entirely. Then put the entire county road system under direct supervision of the highway engineer and motorize the equipment.

While these recommendations were contrary to the State laws entirely, the county court and the tax payers were very much impressed with the suggestion and urged that this be tried out merely as an experiment. The results are that in January of 1935, with the county assessed valuation down to $26,000,000, the special road and bridge tax of only 1½ mills is the only road tax that is paid. Of the 719 miles of public highways, 503 miles are all-weather, there being 61 miles of State concrete highways, 7 miles of bituminous concrete, 51 miles of State high-type gravel, 384 miles of county gravel, 130 miles of graded earth county highways, and 86 miles of unimproved county highways.

Every city, town and hamlet in Marion county is on some kind of all-weather road, and all but three of the

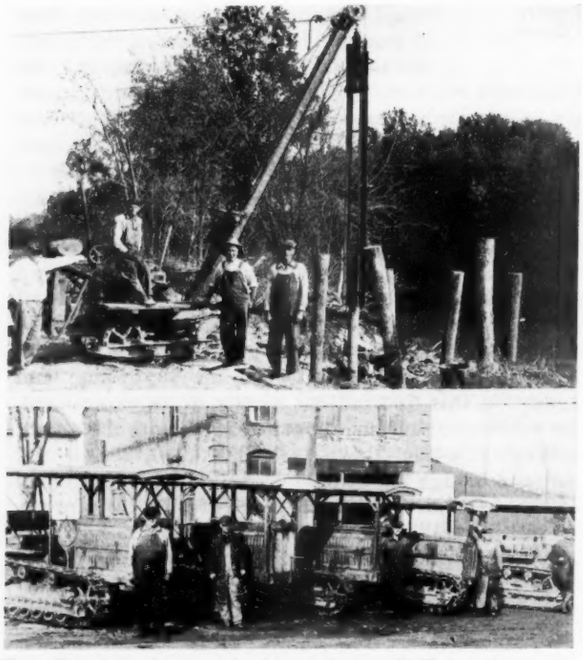
rural schools enjoy the same convenience. All county highways, as well as State highways, are maintained whenever necessary. With the exception of a few times during the winter months, when freezing and thawing is at its worst, the entire road system is in excellent condition.

The county department puts from 16 to 17 cubic yards of material per station on its main highways and as low as 10 yards per station on some of the by-roads; this material being usually taken as pit-run and either crushed and screened or double screened to comply with the county specifications relative to oversize, sand and foreign matter. The material is placed in a windrow between the center line of the highway and the shoulder and is then bladed about one inch thickness at a time as often as is necessary until the windrow is consumed. The width of the gravel pavement depends upon the importance of the road.

This county does all of its own construction work. It has not let a road or bridge contract since 1928. All foremen are hired by the engineer and they hire such others as are necessary to carry on the work assigned to them, and in accordance with plans and specifications prepared by the engineer.

As mentioned before, Marion county handles its financial affairs different from any other county, so far as is known. Instead of advancing the funds as heretofore mentioned, all work is done under the supervision of the engineer. Each foreman makes out time sheets in triplicate, the original and duplicate being filed with the engineer and the triplicate remaining in the foreman's book. The engineer's office types up a supplementary backing sheet, showing the amount due to each person and connects this backing sheet with the time sheet, the duplicate being kept in the engineer's files and the original being sent to the county clerk's office for audit. After it is audited it is presented to the county court, and when the bill has been approved by the county court the county clerk issues a warrant for the amount due each individual appearing on the sheet. The warrants are then sent to the treasurer's office, who in turn writes his personal check to correspond with each individual warrant. Those checks are sent to the engineer's office which checks them against the duplicate copy of the bill; then, if no error appears, the checks are distributed to the individuals to whom they are written. In addition to this, ledgers are kept in each office and are open for inspection to anyone who wishes to see them.

Top—Opening new Bay Island road—almost ready for surfacing. Bottom—A finished gravel road. 880 cu. yd. per mile; cost 35 cts. a yard to haul. Total cost $525. per mile.



Top—Pile driver in county's shops, using small Cletrac for power. Bottom—County's power units ready to start for a season's run.

It has been said many times and in many places, and is shown by the county statistics of 1932 compiled by the American Road Builders' Association, that Marion county can show a higher percentage in miles of all-weather roads than any other county in the United States, although the county has never voted a road bond issue, has never done any road improvement on borrowed money, and as a general rule carries a very low valuation and tax levy. While it is true that there are many counties that can show more miles and higher type road than Marion county, they also have a tremendous bond issue, or extremely high valuation and tax levy, and in some cases all of these elements prevail.

At the close of the year 1934 the Marion county highway department carried a balance of approximately $22,000. This county has never voted a road bond issue, never bought anything except on a cash basis, and during the 116 years of existence no county warrant has ever left the court house—this county does not carry any bonded indebtedness whatsoever.

One of the main projects of recent years was the building of the Bay Island roads. Bay Island (the Bay being a part of the Mississippi river) is about six miles long and from two to three miles wide. Until 1931 there was nothing but dirt roads on the Island, and should the levee have broken, it would have been impossible for all of the residents to escape. In the Spring of 1931 the engineer called a meeting of the taxpayers and tenants of this area and worked out a plan to surface these roads in order to afford them protection, building as cheap a road as possible and at the same time making it heavy enough to stand up under heavy hauling.

The engineer made the following proposition to the

(Please turn to page 28)

Elements of Coagulation for Water Filtration*

By George D. Norcom
Sanitary Engineer and Chemist

THE most perfectly designed rapid sand filter plant will not function properly unless satisfactory coagulation is accomplished. The chemical coagulation of drinking water is frequently difficult because the recations must be made to take place in extremely dilute solution. The object is to produce the best possible floc which will properly clarify the water with the least amount of chemicals and leave a minimum of coagulant in solution in the filtered water. In actual practice such perfection is not attainable all of the time, but every effort should be made to attain it as much of the time as possible.

Lewis B. Miller has stated that three things are necessary of attainment in properly coagulating any water: "(1) There must be added a certain minimum quantity of aluminum ion; (2) there must be present an ion of strong coagulating power, such as the sulphate ion; (3) the hydrion concentration must be properly adjusted." These statements apply equally to iron compounds.

The Chemicals Used

While compounds of aluminum have long been used for coagulating water and are still the most popular coagulating chemicals, ferrous sulphate and lime are used to a considerable extent, and within recent years ferric salts, principally ferric chloride and ferric sulphate, have been developed to a point where they promise to become very important for clarification purposes. (Chlorinated copperas is a mixture of ferric chloride and ferric sulphate, prepared by adding chlorine to a ferrous sulphate solution.)

High calcium lime and soda ash, alkaline substances, may be considered supplementary to the above, the use of which jointly with them frequently is necessary for satisfactory coagulation. Acids—sulphuric or phosphoric—are used infrequently in conjunction with the alum process.

The proper mixing of the chemicals with the water, bringing them rapidly in contact with *all* the water, is of fundamental importance; but once this is effected, the floc begins to form and violent agitation would prevent its agglomerating into the desirable large flocs. Such agglomeration is aided by a gentle "rolling up" of the floc, either by slowly moving stirring apparatus or by baffles, at a velocity just high enough to prevent its settling, for a period of 15 to 30 minutes.

Having brought about the formation of a suitable floc, the next step is to permit practically all of it to settle out in the shortest possible time. This is effected in a coagulation basin, through which the coagulated water flows slowly. The time required for proper sedimentation of the floc is dependent on a number of things, among the most important of which are the nature of the raw water, the kind of coagulant used, the degree of clarification required, the efficiency of mixing and settling, the temperature of the water, and the nature of the sludge produced. Most basins are designed for a 4- to 6-hour retention of the water.

Every coagulation basin should include the following features:

1—An inlet designed to admit the treated water evenly throughout the entire cross-section of the flowing-through compartment, but without unduly disturbing the sludge.

2—A retention period long enough to produce a thoroughly clarified water.

3—An outlet designed to skim off the upper layer of clarified water and conduct it to the filters without destroying the particles of floc.

4—Suitable sludge outlets and water under high presure available from numerous connections for flushing purposes.

Scrapers which remove the sludge mechanically by drawing it to suitable outlets while the basin is in operation are used in some modern coagulation basins, are highly desirable in many cases and absolutely essential for certain treatment processes, notably lime-soda softening.

How to Determine the Correct Dosage

Before establishing the chemical dosage required properly to coagulate a given sample of raw water, it is necessary to know its color, turbidity, temperature, alkalinity and pH, while the hardness and free CO_2 are of interest. The mimimum quantity of coagulant required varies directly with the color and turbidity. Temperature is important because of the difficulty of securing good floc formation in very cold water; below 40°F more coagulant may be required to do the same work accomplished by a smaller amount in warm weather.

Alkalinity is the measure of the carbonates and bicarbonates, which react directly with the acid salts of aluminum and iron to form the hydroxides which we call floc. Theoretically, one grain per gallon of commercial aluminum sulphate requires 7.7 ppm. of alkalinity for complete precipitation; but part of the aluminum ion appears to combine directly with impurities in the water and the amount of alkalinity actually required varies from 4 ppm. for highly colored waters, to between 6 and 7 for clear or turbid waters.

The determination of pH is of value as a corollary to the tests for alkalinity and free CO_2. With low free CO, and high alkalinity the pH will be high; with low free CO_2 and low alkalinity the pH will be moderately high, while in the presence of high free CO_2 the pH is generally low.

In general, it may be said that for any natural water there is at least one definite range of pH within which good coagulation will take place. The pH where the best floc occurs in the shortest time is called the "optimum point." The optimum for the various coagulants, while varying with the characteristics of the raw water,

*Condensed from a paper before the Pennsylvania Water Works Operators Association.

will usually be found to lie within the following pH ranges:

Aluminum sulphate—4.0 to 7.0
Ferrous sulphate—8.5 upwards
Chlorinated copperas, Ferric chloride, Ferric sulphate } (a) 3.5 to 6.5 (b) 8.5 upwards.

In the pH range below 6.5 the sulphate ion has a strong coagulating effect while the chloride ion has a lesser effect. In the alkaline range above 8.5 the calcium ion is very effective and the sodium is less so. Expressed in the simplest terms, this means that in general the higher a water is in total solids, the broader will be the pH range in which coagulation occurs.

For waters which require excessive quantities of alum or the use of acid to reach the optimum, ferric compounds are useful since they can be coagulated in either a low or a high pH range. Since alum can be used only in a low pH range—usually less than 7.0—the filtered water will be corrosive, which condition should be corrected following filtration; but iron coagulation at high pH can be designed to correct for corrosion and no further adjustment of the filtered water is necessary. For water that contains undesirable amounts of iron or manganese, or both, the iron coagulation process is plainly indicated.

Making "Jar Tests"

In order to determine, for each change in raw water condition, the chemical doses that are most effective, every rapid sand filter plant should be equipped with apparatus for conducting coagulation tests, commonly called "jar tests." The apparatus needed includes 6 glass jars, either one quart or one gallon capacity, preferably the latter; stirring rods, pipettes, pH test equipment, and standard solutions of coagulant and alkali or acid. A device for mechanical stirring is more satisfactory than hand stirring and gives better results.

To make the test, fill the jars with freshly drawn raw water, and dose them with various measured quantities of the coagulant solution (and the alkali or acid solution if necessary), ranging from less than is thought to be necessary in the first to more than probably is necessary in the sixth. The chemicals are added rapidly, and the treated water is stirred vigorously for three minutes and slowly for 15 minutes and then allowed to subside quietly for three or more hours. If, from this test, it seems probable that the optimum dose has not been included, another series is run with doses above or below those of the first series, until the minimum dosage is found that gives satisfactory coagulation.

In judging coagulation, the following criteria should be used:

1—The time of first appearance of floc.

2—The appearance of floc in 5 minutes and in 30 minutes.

3—The appearance of the supernatant liquid and the settleability of the floc at the end of a period of time corresponding to the retention period of the plant sedimentation basin.

During the test, it is important that the temperature of the water in the jars be maintained at approximately the same temperature as when taken. A pH determination on the water in each jar must be made 5 minutes after the preliminary mixing is completed. A record of a test would have the following general form:

Form for Recording Jar Tests

Raw water at 7 A. M., May 15, 1934. Color 10, Turbidity, 50. Temperature, 62° F. Alkalinity, 45, pH, 7.0. Free CO_2, 9.

Jar No.	*Alum added g. per g.*	*Lime added ppm*	*First floc*	*Appearance 5 min.*	*Appearance 30 min.*	*Appearance 3 hrs.*	*pH*
1	0.5	0	None	.....	.....	.....	6.9
2	0.6	0	10 min.	Smoky	Smoky	Smoky	6.9
3	0.7	0	5 min.	Fair	Fair	Fair	6.8
4	0.8	0	2 min.	Fair	Good	Good	6.7
5	0.9	0	1 min.	Good	Good	Excellent	6.6
6	1.0	0	1 min.	Excellent	Excellent	Excellent	6.4

From the above it is apparent that a dosage of 1.0 grain per gallon of alum, without addition of alkali is close to the optimum for this water, and that a pH of 6.4 should be maintained on the water in the mixing chamber.

The ability to tell, in the actual operation of the filter, whether or not the dosage is satisfactory is largely a matter of experience, but the following suggestions will be helpful to the novice.

"The quality of the floc in the mixing chambers and sedimentation basins, as well as the appearance of the filter influent, should be observed hourly by the operator. A submerged waterproof light is useful for this.

"With rapidly fluctuating raw waters or those in which good coagulation is difficult to maintain, a quart jar of water from the mixing chamber should be taken every hour, the pH recorded, and the jars preserved in a row upon a table until eight have been collected. These samples form a continuous historical record of the coagulation process and serve to prove to each successive shift operator and to the superintendent that the operator responsible for them has performed his duty faithfully and well.

"In a well-coagulated water the particles of floc are distinct and well-formed, and the water should show numerous clear spots between the particles. After 5 or 10 minutes' settling in a jar, particles of floc at the center of the jar should be clearly visible when looking sidewise through the liquid.

"A cloudy or smoky appearance of the treated water indicates incorrect dosage."

How Marion County Handles Highway Work

(Continued from page 26)

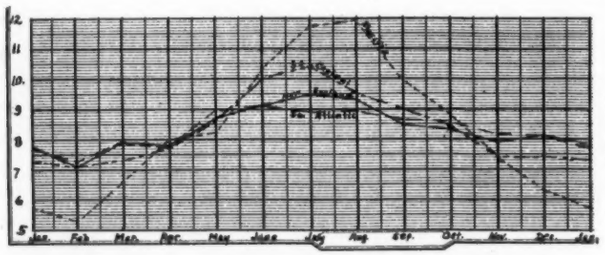
people: The property owners must give all right-of-ways, and the use of their teams to haul gravel on the short ends of the haul. The county would clear, grub, and prepare subgrade and furnish its trucks to haul materials on the long hauls. By this arrangement the ten miles of road cost the county $6,635 to the following specifications:

Subgrade crowned 22 feet wide, side ditch 2 feet deep, 2:1 inslope, 1½:1 backslope, and 10-degree curves.

Surfacing: Hard limestone gravel 100% passing two inch screen, not more than 20% passing a ¼ inch screen. To be dumped in a windrow with center line of windrow six feet to side of center line of road, dumping twenty cubic yards per station and spreading with blade one inch of thickness at a time as it binds, until the windrow is consumed.

This started a movement in the county, all the farmers wanting to build and repair road on the same basis; and it is safe to say that more than one hundred miles of county roads have been built on that plan during the last three years.

Studies in Water Consumption



Monthly consumption by cities in four sections of the country

Below are given figures of water consumption by months in the eight South Central States, the figures being percentages of the total annual consumption of the city in question, without reference to per capita consumption. The small table shows the average percentages for four sections of the country, which also are plotted in the diagram, whereby the peculiar features of each are brought out. The most prominent characteristic is the big summer rise in the Pacific states, due, presumably, to use of a considerable part of the supply for irrigation.

Average Monthly Consumption (Percentage of Total for the Year) in Four Sections of the Country

	Jan.	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
New England	7.81	7.10	7.89	7.76	8.69	9.08	9.51	9.28	8.53	8.31	7.93	8.11
South Atlantic	7.74	7.30	7.91	7.68	8.95	9.10	8.86	8.93	8.66	8.62	8.16	8.11
South Central	7.30	7.06	7.30	7.69	8.66	9.95	10.35	9.51	8.99	8.36	7.42	7.41
Pacific Coast	5.71	5.28	6.56	7.99	8.21	10.28	11.67	11.91	9.87	8.81	7.43	6.28

Monthly Water Consumption, in Percentage of Total Annual Consumption, for Cities of the South Central States

City and State	*Population*	*Percent metered*	*Consumption*	*Jan.*	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Arkansas															
Fort Smith	35,000			7.00	7.00	7.30	6.13	7.95	9.36	11.80	8.77	8.45	8.24	7.10	10.95
Fayetteville	10,000			7.67	7.39	7.99	8.09	9.36	9.85	9.87	8.28	8.08	8.06	7.74	7.62
Pine Bluff	20,000	99	94	6.80	6.60	7.00	7.76	8.72	9.22	10.25	10.75	9.70	8.24	7.76	7.27
Van Buren	5,042	99	48	8.59	8.59	6.85	7.23	7.33	8.59	10.16	9.32	9.53	9.28	6.81	7.70
Kentucky															
Paris	6,200			8.25	8.00	7.92	7.95	8.60	8.90	9.43	9.15	8.76	8.16	7.45	7.47
Ashland	29,074			7.40	6.79	7.59	7.48	8.22	9.70	9.71	9.60	8.91	8.45	8.11	7.97
Ludlow	6,850			7.58	7.68	6.36	7.35	8.13	9.50	9.33	10.27	9.21	9.83	7.06	7.70
Covington	68,252	100	70	7.62	7.09	8.53	7.98	8.00	10.30	9.62	9.55	8.53	8.11	7.59	7.11
Hopkinsville	14,992	76	48	8.38	7.54	7.84	7.83	8.65	8.62	9.03	9.30	9.56	8.17	7.46	7.58
Louisville	315,000	51	123	7.73	7.39	7.32	7.12	8.00	10.37	10.35	9.25	8.56	8.14	7.73	7.98
Morganfield	2,551	100	35	7.45	7.02	6.58	7.13	6.98	8.00	9.76	9.62	10.00	9.29	8.95	9.20
Tennessee															
Maryville	5,000			9.14	8.59	9.04	8.97	9.64	8.84	7.84	7.13	7.84	8.34	7.68	6.95
Murfreesboro	8,783			7.38	6.98	7.54	7.45	8.61	9.28	9.48	9.76	9.24	9.70	8.14	6.44
Nashville	157,900	100	92	7.75	7.24	7.60	7.22	8.82	9.41	9.55	9.24	8.76	8.40	8.03	7.98
Knoxville	105,000	100	76	8.09	7.43	7.72	7.82	8.77	9.11	9.19	8.86	8.56	8.53	8.04	7.88
Alabama															
Talladega	8,000			8.31	6.75	7.65	7.53	7.74	11.14	8.53	8.55	8.65	8.76	8.16	8.24
Mississippi															
Canton	4,500	93	82	6.85	7.57	6.66	7.85	11.89	11.87	8.33	7.92	8.47	7.85	7.64	7.10
Jackson	48,257	78	94	8.99	9.07	7.91	7.56	8.26	8.47	8.15	8.80	9.28	8.53	7.55	7.52
Natchez	13,500	100	50	6.91	6.05	6.81	8.05	9.34	9.81	9.53	9.54	10.31	8.88	7.89	6.89
Meridian	32,000			7.13	7.98	8.59	9.56	8.98	9.43	9.05	8.19	8.05	8.08	7.49	7.48
Louisiana															
New Orleans	500,000			7.48	7.50	7.30	7.53	9.11	9.09	9.32	9.53	9.09	8.59	7.83	7.63
Texas															
El Paso	100,000			5.81	5.85	8.15	9.50	11.58	9.36	10.73	10.32	9.14	7.20	6.15	6.22
Hearne	3,000			6.33	6.37	6.68	7.03	8.59	10.57	11.98	10.86	9.99	8.05	6.83	6.71
Austin	65,000	100	86	6.95	6.65	7.09	7.94	9.91	10.67	11.08	9.73	8.90	7.55	6.63	6.88
Dallas	275,000	100	84	6.80	6.56	7.35	7.34	7.94	10.88	11.93	9.97	8.75	8.00	7.12	7.27
Del Rio	11,000	100	100	6.45	6.88	7.52	8.60	9.03	9.25	9.46	9.67	10.76	9.03	6.45	6.88
Greenville	12,580	100	46	7.54	8.17	6.68	7.36	7.22	8.56	8.76	9.05	10.10	9.02	8.43	9.06
San Antonio	260,000	100	78	6.41	6.27	6.16	7.92	8.89	10.62	11.76	10.83	8.91	7.70	7.50	6.98
Amarillo	43,132	100	75	5.53	5.71	6.49	7.73	8.77	12.21	13.80	10.68	8.31	8.43	6.41	5.93
Burkburnett	3,250	100	150	8.17	7.72	8.40	7.85	8.03	8.48	9.25	9.45	9.08	8.60	7.78	7.26
Graham	5,000	98	70	5.35	5.12	5.97	7.12	7.94	12.93	15.28	11.17	8.21	8.40	6.18	6.36
Houston	293,000	100	85	7.29	7.29	7.59	8.22	9.29	9.79	9.22	8.61	8 65	8.51	7.77	7.78
Paris	16,000	100	50	7.50	6.94	8.03	8.22	8.42	11.95	10.70	9.17	8.13	7.10	6.82	6.96
Wichita Falls	43,690	100	59	6.45	5.98	7.32	6.95	7.89	10.21	13.83	9.96	9.18	8.28	7.28	6.67
Oklahoma															
Mangum	4,780			6.60	6.16	5.77	7.05	8.80	10.56	11.45	12.32	10.56	7.93	6.16	6.60
Bartlesville	15,000	100	45	7.50	7.90	6.50	7.45	7.72	10:57	12.22	9.42	8.40	8.18	7.38	6.73
Oklahoma City	185,389			6.83	6.45	6.76	7.31	8.29	11.89	12.85	8.88	8.79	7.75	7.11	7.09
Enid	26,000	100	36	8.36	6.83	7.29	7.76	8.47	8.70	10.00	9.64	8.88	8.84	7.72	7.51
Henryetta	7,000	75		6.49	6.25	6.65	7.26	9.83	11.44	11.08	9.94	8.17	7.84	7.54	7.51
Average				7.30	7.06	7.30	7.69	8.66	9.95	10.35	9.51	8.99	8.36	7.42	7.41
Maximum				9.14	9.07	9.04	9.56	11.89	12.93	15.28	12.32	10.76	9.83	8.95	10.95
Minimum				5.35	5.12	5.77	6.13	6.98	8.47	7.84	7.13	7.84	7.10	6.15	5.93

Water Light and Power

310 E. 45th St., New York, N. Y.

A Special Supplement to PUBLIC WORKS *magazine devoted to the interests of publicly owned utilities.*

Litchfield, Minn. is proud of this efficient municipal light and power plant.

Profits From Municipal Utilities Pay for Many Improvements in Litchfield, Minn.

Recent additions to plant improve operation and lower costs of producing current.

LITCHFIELD, Minnesota, with a population of about 3,000, has for 35 years operated a light, power, heat and water utility so economically and efficiently that its earnings have paid for the city's sewage treatment plant as well as for additions to the utility; and electric service for the white way, street lighting, fire hall and other municipal buildings, heating of the fire hall and opera house, power for sewer pumping and the treatment plant, and fire protection, are furnished free—a service estimated to be worth between $9,000 and $10,000 a year.

The result is that the citizens of Litchfield, as taxpayers, pay approximately 25% less per capita than those of the corresponding city of Hutchinson (which, however, is served by a private utility); while as users of the utilities they pay rates which are very low in comparison with communities served by private utilities. The present residential lighting schedule, for example, is 7 cts. per kwh. for the first 30 kwh. and 2 cts. for all over this, with a minimum of $1.00.

The Electric Plant

In 1898 the citizens voted a bond issue of $25,000 to build a municipal lighting plant. The original system, small power house and two 75-kw. 1100-volt A. C. belted generators operated in conjunction with two HRT boilers. Later, as the load grew, a 150-kw. steam engine-generator belted unit was added.

In 1915, a 4-valve steam engine direct connected to a 250-kw. 3-phase 60-cycle A. C. generating set was installed. At the same time, the distribution system was changed from 1100 to 2300 volt, effecting better distribution efficiency. At this time, the boiler plant consisted of three 150-hp. HRT boilers, which a few years later were equipped with underfeed stokers.

In 1922 it was decided to remodel the plant completely as the load had grown steadily and it was deemed necessary and advisable to get additional capacity and construct a new building. At this time a 400-kw. uniflow steam engine with direct connected generator was installed, together with a 300-hp. water-tube boiler equipped with multiple-retort underfeed stoker.

Use Exhaust Steam for Heating

In addition to selling electrical energy, the municipality operated the water works and sold exhaust steam heat for various buildings in Litchfield. During the next period, the steam heat load grew quite rapidly, with the result that in 1925 it was necessary to install a 400-hp. water tube boiler equipped with a multiple-retort underfeed stoker. At that time the old HRT boilers were removed and at the same time, a new 12-panel switchboard was installed so as to permit of proper segregation of the various sections of the distribution system.

During the next few years, the Village of Litchfield extended its lines outside the corporate limits, taking on load from Drawin, Forest City, Grove City and several other communities, together with approximately 70 miles of farm line, and by 1931 the load had grown to a point where additional generating equipment was required. The engineer consulted advised that, with the large steam heating load in effect, a 750-kw. bleeder type steam turbine unit would make the best installation,

Pages 47, 48 and 52 contain descriptions of many helpful booklets—Don't forget to look them over.

and such a unit was installed, with cooling tower for cooling the circulating water.

In 1933, it was found that the electrical load was increasing by leaps and bounds but that the steam load was practically stationary. It was also found that the electrical requirements were such that the small boiler could not handle both the steam and electrical load, and it was necessary to use the large boiler continuously during the winter months. A thorough investigation was made as to the proper solution to this problem, which resolved itself into one of two things:

A—That a new boiler be installed immediately and that in the future another steam turbine unit be installed at a total investment of approximately $90,000.

B—Install a diesel generating unit to effect economies of steam operation during the summer months and act as standby to the steam equipment during the winter months, at an initial investment of approximately $60,000..

Even with the large boiler off the line, the small boiler could handle the steam load and the Diesel the electric load, thus the Diesel would therefore be acting as standby during the winter months for both the steam generating and electric generating equipment.

Bids were received for making these changes and a contract awarded for a 606-kw., 875 hp. Fairbanks-Morse diesel generating unit, which was installed during the summer of 1934. Operating data have been accumulating for too short a time to permit accurate determination of costs, but they indicate that the fuel cost per kwh., including coal for keeping one boiler under steam for emergency standby, is approximately 0.4 ct. (Superintendent J. C. Bang informs us that "the average total generating cost per kwh" for the year ending April 2, 1934, was 1.69 cts.)

Changes Save Approximately 5 Mills Per KWH

The results obtained in this installation indicate that the heat balance where steam heating is not required for certain periods of the year can be best obtained by a combination steam and diesel plant. The steam equipment is operated during the winter months and a portion of steam bled to the heating system. During the fall and spring, part of the load may be carried by the diesel and part by the steam, with a sufficient electric load carried from the steam unit to give the necessary exhaust steam. During the summer months the diesel unit carries the full load, with savings of approximately 5 mills per kw.-hr. between diesel operation and steam turbine condensing operation. This means an annual savings of approximately $9,000 to the citizens of Litchfield. A portion of this savings is due to the high auxiliary losses of the steam turbine under the variable load conditions existing in this municipal plant.

In addition to these changes to the electric plant, the water works plant was improved by the addition of a new well, a 400 gpm. F. M. motor-driven turbine pump to replace the old duplex steam pump, and fifteen blocks of new mains. The cost of these improvements was $71,000, all to be financed from net earnings.

Combined Plant Shows Net Profit

The total value of the light and power plant, local and rural distribution systems is $246,153, after deducting $11,290 depreciation. The waterworks mains, tank, pumps, wells and other equipment have a depre-

(Continued on page 41)

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

HEATING digestion tanks to 95° to 100° is believed preferable to either lower or higher temperatures. Digesting sludge does not absorb heat from iron pipes nearly so readily as does water, both because the sludge adheres to the pipes and forms a heat insulating cover, and because the viscosity of the sludge diminishes the rapidity of convection currents from the hot pipes. Walraven found "With coils submerged in sludge of 12% solids content, the coefficient of heat transfer was found to be about 11 Btu per sq. ft. of heating surface per hour per 1° F. temperature differential. With the same coils submerged in very thin sludge approximating strong supernatant liquor, I found the heat transfer to be 39 Btu." With water circulated at 170° F., a ⅛" crust of hard, brittle substance was formed, which probably reduced the heat transfer. Later, with the temperature kept below 155° for two years, no such crust formed. Springfield experience indicates that increasing the digestion temperature increases the drying time required; "sludge must remain longer upon the beds when it comes from tanks kept at 95° F. than when it comes from tanks heated only to 80° F."[C3-9]

Meadville found digestion, as measured by gas production and volatile matter reduction, apparently as rapid at about 84° F. as at about 94°.[C3-12]

Packinghouse sludge mixed with domestic sewage sludge digests as readily as either alone; in fact, experiments indicated more rapid decomposition of the mixture. These experiments were made at the University of Wisconsin in 5-gallon bottles, where various combinations of packinghouse and domestic sludges and unmixed samples of each were subjected to batch digestion, some seeded and others not. "The fastest rate of digestion was obtained with a mixture of 8 parts packinghouse sludge to 1 part of domestic, seeded with 10% of ripe sludge of the same proportions. . . . Plain domestic sludge seeded with 10% ripe sludge showed slowest digestion as measured by daily loss of solids per liter of liquid sludge.

"Very little if any nitrogen gas is formed. . . . The acid phase was not evident in any packinghouse-domestic sludge mixture of more than 50% packinghouse sludge by volume. Liquids digest to gas more completely than the bulk of total solids."[C3-1]

Coney Island treatment works, New York City, soon to be begun and estimated to cost $1,823,000 and have a capacity of 35 mgd of domestic sewage containing little trade waste, will employ chemical precipitation and chlorination in summer and plain sedimentation in winter, the sludge to be digested with utilization of the gas, dewatered by vacuum filters, and used as fertilizer and humus on large areas of land being reclaimed by sand fill by the Park Dept.

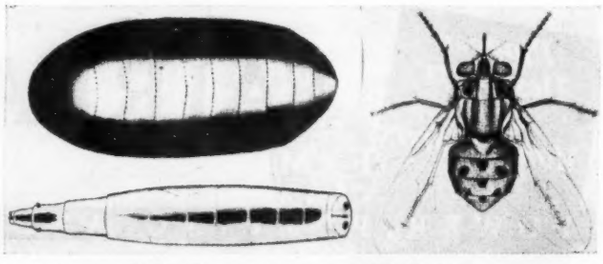
There will be four 90 ft. diameter settling tanks, mechanically cleaned; eight digestion tanks 55 ft. diameter and average 28 ft. depth, heated and with gas-holder type of cover; a vacuum filter with 570 sq. ft. filter surface; five dry-feed machines for lime and ferric sulphate; four chlorine solution machines with a capacity of one ton per 24 hours; and mechanical flocculators preceded by rapid mixing devices. [G3-3]

Activated sludge treatment is not yet thoroughly understood—"although it is known that the purification is due to both physico-chemical and biological reactions, the relative importance of each is still undetermined." It probably occurs in at least three stages: clarification, reactivation, and nitrification. "The first is mainly physico-chemical in nature, although biological action is probably necessary. . . . The second and third stages are chiefly biological and, although the essential organisms have not been identified, both protozoa and bacteria seem to be important. The presence of ciliates, which is said to be indicative of good sludge, may be important in maintaining a balance between the bacteria and protozoa."

Attempts to divide the process into definite stages have not been very successful; no air is saved, operation is more complicated and increased settling area is required.

Oxygen requirements vary from about 27 to 110 ppm per hour for different sludges, the consumption varying with weight of sludge and its volatile content. It has been demonstrated that oxygen is absorbed from air bubbles as well as at the surface of the liquid.[C3-2]

Trickling filter flies, that is, those that breed on trickling filter stones, are generally thought to be confined to the Psychodidae; but stable flies (Stomoxys Calcitrans L.) were found last July breeding by the million on the sprinkling filters at Greenville, S. C. These flies are about the same size and color as the house fly, but possess biting mouth parts, and for 2 or 3 miles around the plant farmers had to cover mules when cultivating cotton, milk production by cows fell off 50%, and residents considered moving. Breeding of these flies in trickling filters has never before been recorded in any entomological publication; nor were any other instances discovered. Since "at least three feedings on blood are necessary for the production of eggs," it is suggested that this instance was due to the fact that sheep and cattle were pastured near the plant.

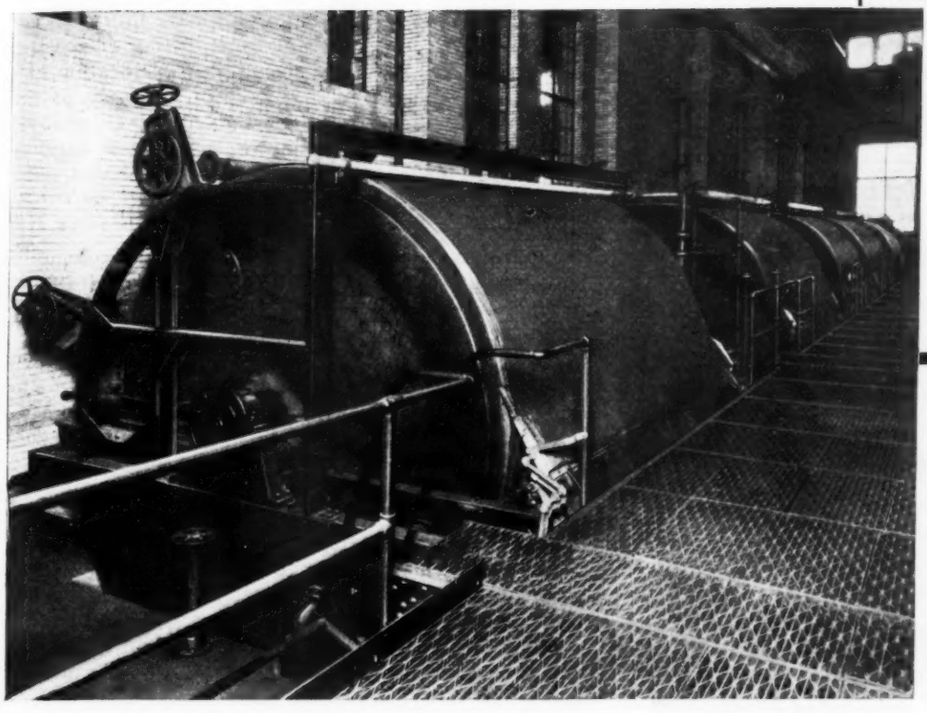


Left, top—**Stable fly pupa**; bottom—**stable fly larva or maggot**
Right—**Adult female stable fly.**

FERRIC CHLORIDE

The following cities have adopted Ferric Chloride as their sludge conditioning agent:

MILWAUKEE, WIS.
ROCKFORD, WIS.
CHICAGO, ILLINOIS
(*West side experimental plant*)
COLUMBUS, OHIO
SPRINGFIELD, OHIO
ANNAPOLIS, MD.
HAGERSTOWN, MD.
HIGH POINT, N. C.
GASTONIA, N. C.
CHARLOTTE, N. C.



Photograph courtesy of Milwaukee Sewerage Commission . . . First plant to use Ferric Chloride in sludge dewatering.

THE use of Ferric Chloride as a sludge conditioning agent is rapidly growing in popularity. It has been proven to be the most effective conditioner for activated sludge prior to vacuum filtration.

The Pennsylvania Salt Manufacturing Company was the first company to produce Ferric Chloride in a form suitable for use in sewage disposal plants at a cost within the range of economical sludge disposal operations.

LIQUID FERRIC CHLORIDE was developed first. Today large plants with railroad sidings find it economical and practical to buy it in this form... because it is shipped direct in rubber lined tank cars.

Sewage plants without railroad sidings are now using Ferric Chloride in Anhydrous form... another development made possible by the Pennsylvania Salt Manufacturing Company.

ANHYDROUS FERRIC CHLORIDE comes in powder form. It is packed in airtight, non-returnable steel drums... Is instantly soluble... And can be stored indefinitely without deterioration or liquification.

Our specialized technical service is available without cost to adapt our products to customers' requirements.

WRITE TODAY *for Free Booklet on the application of Ferric Chloride . . . How and where to use it.*

Est. 1850

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When writing, we will appreciate your mentioning PUBLIC WORKS.

Flooding for 24 hours failed to drown more than 20% of the pupae, but flooding for 12 hours killed all maggots; and after flooding these filters twice a week for a month, breeding of stable flies had entirely ceased.[H3-1]

Low solids content affects efficiency of activated sludge treatment. Study of a hospital plant operated for three years with suspended solids ranging between 150 and 868 ppm showed activation of sludge maintained under continuous plant operation with normal detention periods using solids in amounts as low as 150 ppm. The length of time required for the initial flocculation stage, however, increases with decreasing amounts of solids. While the overall purification efficiency was less, the relative unit of efficiency of the lower solids with respect to first stage B.O.D. removal and clarification was maintained, and was as high or higher than that of the higher solids in the second stage purification.[C3-4]

Suspended solids determination by the volume of centrifuged solids of activated sludge liquors affords a rapid and easy method which is of sufficient accuracy for plant control purposes. In fact, "errors in the gooch method are shown to be as great as the deviation of results calculated from the volume of centrifuged solids." For making this calculation the author gives the formula $x = 450 + (y\text{-}1)\ 600$, in which x = ppm suspended solids and y = per cent sludge by volume in a 15 ml graduated centrifuge tube after 10 minutes' centrifuging at 2,600 rpm. Extreme care must be used in taking the sample; to stop the centrifuge slowly; to read the interfacial surface at the bottom of the sludge meniscus, and immediately after the centrifuge is stopped.

Applying the above formula to activated sludges gave results varying from those by the gooch method by + 16 to — 12%, but the gooch method itself is subject to as great errors.[C3-8]

Dehydrating sewage solids before incineration is economical for plants of 10 mgd, more or less, but not for 5 mgd or under. Coarse bar screenings can be drained if allowed to stand in small batches in a perforated receptacle. Fine screenings can be dehydrated by idler roll belt wringers to about 75% water content; by driven roll, driven screen presses to about 70%; or by batch centrifuges down to 60 or 65%. Below 65% is not warranted by relative costs of incinerating fuel and dewatering power and labor. Grit drains readily; can easily be centrifuged to 60 or 65% water content. Skimmings, scums and greases can be concentrated by decantation to moisture contents of 75% or less. Sludge can be filtered on vacuum filters, fresh raw sludge to between 83 and 75%; activated sludge between 83 and 79%; digested sludge, between 75 and 70%; chemical sludge between 65 and 58%. Other methods of dehydration are theoretically possible but unused as yet on a large scale, such as centrifuging, decantation, chemical separation, etc.

Idler roll belt wringers for fine screenings are used in the three new Westchester, N. Y., plants, and a driven roll-driven screen belt, continuous roll press has been installed at Los Angeles.

Drying sludge before burning is economical in plants of 20 mgd or over. It can be dried to 20% moisture without odor. The trend is away from evaporation in rotary dryers. Drying may be effected with temperature below 100° or above 1250°; between these causes odors. The former is preferred.[C3-8]

Sewer designing in England must be much inferior to American in some respects: An English borough engineer, in a paper before the Institution of Municipal and County Engineers, referred to the "present practice of continuing the invert of sewers (when changing from one size of sewer to a larger one) in even gradients and increasing the sizes of the pipes so that the increase is on the top of the sewer;" and rather apologized for the belief "that where practicable the invert of the sewer should fall by an amount equal to the increase at changes of size."[D1-4] We question if any reputable engineer in this country ever employs the English "present practice" referred to.

Bibliography of Recent Sewage Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

C 3 — *Sewage Works Journal* — *January*

1. *t.* Digestion of Mixtures of Sludge from Domestic Sewage and Packinghouse Wastes. By O. J. Knechtges, F. M. Dawson and M. S. Nichols, pp. 3-16.
2. *t.* A Review of Activated Sludge Theory. By G. P. Edwards, pp. 17-22.
3. *t.* Rapid Determination of Suspended Solids in Activated Sludge by the Centrifuge Method. By L. R. Setter, pp. 23-28.
4. *t.* Activated Sludge Treatment with Extremely Low Solids. By G. M. Ridenour, pp. 29-35.
5. *t.* The Biochemical Oxygen Demand Test, as influenced by the Ratio of Organic Carbon to Total Nitrogen. By J. M. Holderby and W. L. Lea, pp. 36-42.
6. The Combined Collection and Disposal of Sewage and Food Wastes. By Morris M. Cohn, pp. 43-55.
7. Mechanical Equipment in Sewage Treatment. By Chas. C. Agar, pp. 56-59.
8. The Incineration of Sewage Solids. By A. E. Stilson, pp. 60-69.
9. Separate Sludge Digestion Tanks and Their Operation. By W. B. Walraven, pp. 70-81.
10. The Kitchener Sewage Treatment Plant: Its Design, Construction and Operation. By William Storrie, pp. 82-90.
11. Removal of Hydrogen Sulphide in Sewage by Aeration. By W. S. Mahlie, pp. 91-95.
12. Sludge Digestion at Meadville, Pa. By C. H. Young and R. L. Phillips, pp. 96-103.
13. Oil Pollution and Refinery Wastes. Committee Report, pp. 104-115.

D 3 — *The Surveyor*

January 18

1. The Aeration of Sewage with and without Activated Sludge. By H. J. N. H. Kessener and F. J. Ribblus, p. 59.

January 25

2. Sewage Disposal in 1934, pp. 88-96.
3. Sewerage and Drainage in 1934, pp. 96-100.
4. House Refuse and Sewage Sludge Disposal (Combined), p. 124.

February 1

5. Separate Sludge Digestion (Birmingham, England). By E. F. Steele, pp. 207-208.

February 8

6. Elimination of Smells from Sewers and Sewage Disposal Works (in So. Africa). By Harold Wilson, pp. 223-224.

February 15

7. Distribution of Sludge and Refuse on Electrified Canals, p. 254.

E 3 — *Engineering News-Record* — *February 21*

1. Sludge Elutriation Tests Establish Cost Figures. By C. E. Keefer and Herman Kratz, Jr., pp. 289-291.

G 3 — *Water Works and Sewerage* — *February*

1. Sewage Disposal in the United States. By Langdon Pearse, pp. 33-41.
2. The Chicago Combination Aerator and Clarifier. By Lewis H. Kessler and Philip F. Morgan, pp. 47-52.
3. The Proposed Coney Island Sewage Treatment Works. By Richard H. Gould, pp. 53-57.

H 3 — *Municipal Sanitation* — *February*

1. Checking an Outbreak of Stable Flies at Sewage Plant. By W. C. Nettles, pp. 36, 58.
2. Sewage Treatment and Refuse Incineration in Single Plant, pp. 37-38.
3. Chicago's Big Sewage Program Advances, pp. 39-40.

J 3 — *American City* — *February*

1. New Calumet Sewage Treatment Works Nearing Completion, pp. 45-46.

P 3 — *Public Works* — *February*

1. Recent Works for Public Sanitation in the South, pp. 11-12.
2. Brookhaven Rebuilds Its Sewage Treatment Plant. By W. W. Chalk, p. 13.
3. New Sewage Disposal Plant at Decatur, p. 14.
4. Fairhope Sewage Treatment Plant, p. 16.
5. The Birmingham Shades Valley Plant, pp. 17, 18.

Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

The Water Wheel

AMEBIC dysentery is caused by intestinal protozoa, *Endamoeba histolytica,* whose distribution is world wide, and it is said that 5 to 10% of the people of the United States are infected with it. Cysts of it kept moist may survive three to four weeks in feces and 200 days or more in water, but die in a few minutes when dried in air. Very strong solutions of chlorine have no effect on them. Transmission may possibly be by flies, but is most probable by water contaminated by sewage. They are completely removed from water by coagulation and rapid sand filtration—other practicable methods may exist but are not known.[A2-24]

Manganese and iron removal at Lincoln, Neb. is to be effected by a plant (to be completed this Spring) comprising aeration; chlorination; upward-flow contact filters, containing either coke, gravel or pyrolusite; two-hour sedimentation; and rapid sand filtration. The experimental plant indicated that better results were possible without sedimentation, but a 2-hour basin is to be provided for probable future water softening and as an additional safeguard for the present operation. The aerator consists of 3 units of 4 superimposed trays each, the tray bottoms being of 2″ slate drilled with 1 1/16″ holes 6″ on centers, on which is placed 4″ of coke. These will operate at the rate of 28 gal. per sq. ft. per min.; the contact filters at 8 gal. per sq. ft. per min.; the final filters at 4 gal. Completion of the plant by May 15th is expected.[E3-2]

Mineral salts in well water at Bryan, Texas, caused trouble and tastes in cooking and danger of damage to flowers and shrubbery when used for irrigation. Also the water developed an offensive musty odor after entering the mains. The city used wells from two strata, one 300 ft. deep, the other 700 to 900 ft. The water from the former contained a total salts content of 32 grains per gallon, the latter 146 grains. Soil chemists stated that more than 90 grains might injure vegetation. As all the trouble seemed to be caused by the deep wells, the shallow ones were used to their capacity, but this was only about 40% of the demand and the other 60% was derived from the deeper stratum. A mixture in this proportion contained about 100 grains—slightly more than the 90-grain limit, but the mixing is being tried and seems to be satisfactory.

The odor was assumed to be due to organic matter dissolved from the shale and lignite through which the underground water passed. To remove it, the water is passed through a filter of granular activated carbon No. 4 to No. 12 mesh 36″ deep and 10′ diameter; first passing through a sand filter to protect the carbon filter from suspended matter. Both filters are of the pressure type. This treatment, in operation since July 1934, is said to be satisfactory. Total cost of treatment plant, $5,500.[F3-5]

The dry period since 1917 was exceeded during the two or three previous centuries, and water supply plans should be based on meeting demands during periods

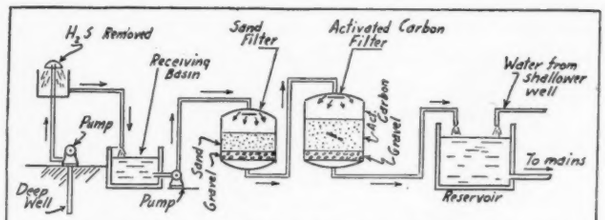


DIAGRAM OF BRYAN WATER SUPPLY AND TREATMENT PLANT

having a run-off similar to that for the period since about 1917. This is the conclusion of Prof. Harding from a study of the levels of the enclosed lakes of the Great Basin, as observed since 1850, and of trees and stumps around the margins of the lakes by which he projects the record backward for another 200 years. He found no cyclic variations which justified projection into the future, except the general one stated above.[L3-3]

The Colorado River Aqueduct, being built to conduct 1500 cfs from the Colorado river for 240 miles, across deserts and through mountains, to Los Angeles, is making unprecedented progress. The forces of the Metropolitan Water District and thirteen contractors are tunneling at the rate of 4 miles a month, and more than 60% of the 91 miles of tunnel has been excavated. There will also be 150 inverted siphons. The District furnishes water, electric power, telephone service and highways to all the contractors.

In computing the dimensions and gradient of tunnels and siphons, a flow of 1605 cfs was used, and Manning's value of 0.013 for n for poured in place concrete, 0.012 for pre-cast concrete, and 0.014 for welded steel pipe; while inlet and outlet losses are taken at 0.1 and 0.2, respectively, of the change in velocity head; and bend losses are calculated as $0.25 \frac{v^2}{29} \sqrt{\frac{A}{90}}$, in which A is the angle of the bend, in degrees.[L3-2]

Spillway construction of Melfort, Sask., water works dam in 1933 included velocity breakers to prevent washing out of spillway channel, which happened in the 1933 Spring run-off. The first fifty feet of the 60-ft. channel was paved with reinforced concrete, in which were set twenty concrete triangular blocks, arranged staggered in three transverse rows, each block being about a foot high and 4 ft. wide, with one angle pointing down stream, spaced 4′ apart transversely and longitudinally. These acted very successfully during the 1934 Spring run-off of about 1100 cfs. The new spillway was designed to carry 3,000 cfs.[M3-3]

Compound-pipe problems, involved in designing a distribution system, are generally solved by the "equivalent pipe" or the "trial and error" method, the former being "the only one which offers an explicit and

Pages 47, 48 and 52 contain descriptions of many helpful booklets—Don't forget to look them over.

a reasonably accurate solution." A new method is described, based on an analogy between hydraulic flow and electric currents, which uses an electric calculating board or network analyzer, wherein each pipe or element in the hydraulic system is represented by a resistor in a similar electric network, while the reservoir or pump is represented by the battery.

Equations for solving the pipe problem are based on three laws: "1—The algebraic sum of the rates of discharge toward any junction point is zero. 2—The algebraic sum of the head losses around any closed circuit is zero. 3—For any pipe or system of pipes the head loss is directly proportional to some power of the discharge." By substituting "currents flowing into" for "rates of discharge toward" in No. 1, and "voltage drops" for "head losses" in No. 2 we have Kirchhoff's laws for electric currents. Modification of Ohm's law for direct current circuits makes it analogous to No. 3. The method of solution is applicable to hydraulic networks containing as many as 60 to 80 pipe elements.[B3-1]

Prof. Babbitt, however, contended that this method involves more calculating than the cut-and-try method if the system is very simple, although possibly less if it is very complicated; but it requires "possession of the electrical equipment, the ability to set it up, the knowledge required to use it, and the time consumed in the computations."

Another method for pipe flow computations, where the system is simple and particularly for those consisting largely of separate loops not interconnected at many places, is a modification by Prof. Howland of the John R. Freeman method. In this, the curve of head loss against flow for each of the pipes involved in the problem is plotted on a separate card, and these cards then fitted together and moved in relative position; the general principle forming the basis of this adjustment of curves being: "The head loss by every path between any two points in the system must be the same, and the sum of the flows in the various paths to every point must equal the total of the flows away from that point."[B3-2]

Carrying capacity of a 12-mile run of 24-in. c.i. pipe at Utica, N. Y., has been maintained for a year or more by chlorination, maintaining a residual of 0.2 ppm. Presumably this was because it prevented growth of iron bacteria; but whatever the cause "by application of chlorine and ammonia, with the characteristics of the water as shown in the tables, in a cast iron main, we have succeeded in maintaining the carrying capacity of this line, which heretofore, after each of the numerous cleanings, would lose up to 20% or more in a period of 6 months."[A2-27]

Wood-stave pipe was first used in Russia in 1927 because other structures of the five-year plan made such demands on the iron supply. Methods and machinery for manufacture were developed in 1926 and 72,500 ft. of pipe produced in 1927. The use increased to 2½ million lineal ft. in 1933 and probably 10 million in 1934. The material used is mostly pine—some larch and fir. Pipe lines of 44 in., 48 in., 52 in. and 64 in. have been constructed with pressures up to 200 ft. head.[E2-1]

Pipe breaks in Sheboygan occurred in three 30" mains under totally different conditions within a few days. They are believed to be due to contraction of pipe caused by cold, and the fact that the joint lead extended back onto the bead of the spigot, which caused a wedge action of the bead as it was pulled forward in the bell. To prevent such action, the author recommends that enough jute or braided hemp be used in a joint to prevent the lead or joint compound extending up onto the slope of the bead, and possibly that on straight runs of pipe, pipe without bead on the spigot end be used at intervals. Similar breaks in Milwaukee in 36" pipe were studied exhaustively — stresses, chemical analyses, metallographic examinations being made. Legal complications of damage suits prevent making the results public at present.[A2-23]

Bibliography of Recent Water Works Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

B 3 *Journal, New England Water Works Ass'n* — *December*
1. *t.* Hydraulic Analysis of Water Distribution Systems. By Means of an Electric Network Analyzer. By Thos. R. Camp and H. L. Hazen, pp. 383-407.
2. *t.* Expansion of the Freeman Method for the Solution of Pipe Flow Problems. By W. E. Howland, pp. 408-411.
3. Public Works for Economic Stabilization. By Willard T. Chevalier, pp. 412-422.
4. A Recent Improvement in the Centrifugal Casting Process. By H. W. Stuart and S. E. Linderman, pp. 423-440.
5. Public Works and Business Stabilization. By R. S. Merriam, pp. 441-450.
6. Modern Aspects of Water Purification. By E. Sherman Chase, pp. 451-459.

D 3 *The Surveyor* — *January 25*
1. Water Supply in 1934, pp. 100-106.

E 3 *Engineering News-Record* — *January 31*
1. Water Resources Inventory Presented by Federal Body, pp. 169-173.

February 14
2. Manganese and Iron Removal Plant for Lincoln, Neb., pp. 246-247.

February 21
3. Prestressed Concrete Pipe Tested at Purdue. By Ray B. Crepps, p. 275.

F 3 *Water Works Engineering* — *February 6*
1. Controlling Water Resources. By Wm. W. Brush, pp. 115-118.
2. Water Hammer in Water Supply Engineering. By S. Logan Kerr, pp. 119-120.
3. Sanitary Water Examinations. By J. J. Hinman, Jr., pp. 121-123.
4. Modern Devices for Improving Water Works Maintenance. By L. A. Smith, p. 137.
5. Dilution and Carbon Treatment Make Salty Water Palatable. By E. W. Steel, p. 138.
6. Some of the Effects of Drought on Public Water Supplies in Iowa. By A. H. Wieters, pp. 141-142.

G 3 *Water Works and Sewerage* — *February*
1. Are Water Utilities a Good Investment? By C. H. Capen, Jr., pp. 42-44.
2. Elimination of Check Valve Slam. By H. K. Palmer, pp. 45-46.

J 3 *American City* — *February*
1. Chlorinated Copper as Treatment of a Low Alkalinity Surface Supply, pp. 49-50.
2. New Bedford Completes New Concrete Supply Line, pp. 57-58.
3. Water Rates and Service Charges (11 cities), pp. 71, 73, 75.

K 3 *Proceedings, Am. Soc. of Civil Engineers* — *February*
1. Frictional Resistance in Artificially Roughened Pipes. By V. L. Streeter, pp. 163-186.

L 3 *Civil Engineering* — *February*
1. Foundation Conditions for Grand Coulee and Bonneville Projects. By Chas. P. Berkey, pp. 67-71.
2. Colorado River Aqueduct Makes Rapid Progress. By F. E. Weymouth, Julian Hinds, J. L. Burkholder and J. (Agnew, pp. 72-86.
3. Changes in Lake Levels in Great Basin Area. By S. T. Harding, pp. 87-90.

M 3 *Canadian Engineer* — *February 5*
1. Progress on the New Extension for Toronto Water Works System, pp. 9-12.
2. Problems in Thawing Frozen Water Mains. By C. A. Holmquist and A. F. Dappert, pp. 17-18.

February 19
3. Additions to Water Supply of Melfort, Sask. By J. E. Underwood, pp. 3-4.

P 3 *Public Works* — *February*
1. 8,000 Tons of Cast Iron Pipe Replace Wood at Miami. By Wm. Sydow, p. 12.
2. New Water Supply at Sylacauga. By H. F. Wiedeman, p. 14.
3. Hanceville's Up-to-Date Iron Removal Plant. By F. C. Basenberg, pp. 15-16.
4. Solving a Problem in Iron Removal. By H. F. Wiedeman, p. 18.
5. Water and Light Plant Owned by Orlando, Fla., Earns a Profit for Its Citizens. By M. W. Brown, pp. 31-32, 38, 44.
6. Activated Carbon in Richmond, Va., Filter Plant, p. 36.

Federal Power Survey Shows Municipal Plants Charge Lowest Rates

A REPORT has just been issued by the Federal Power Commission giving the domestic and residential rates for all cities of 50,000 population and over as of January 1, 1935.

Among the cities of 100,000 population or more, Cleveland and Columbus, Ohio, both with municipal plants, report the lowest charge of 60 cents for 15 kwhrs. For 25 kwhrs and 40 kwhrs Cleveland is also lowest with charges of 88 cents and $1.31 respectively. For the larger consumptions, the lowest rates are charged by the municipal plant at Tacoma, Wash.: $2.40 for 100 kwhrs, $3.90 for 250 kwhrs, and $6.40 for 500 kwhrs.

Madison, Wis., is the only city not having a municipally owned plant to win an undisputed place among those with lowest rates, its rate of $2.73 for 100 kwhrs being the lowest for cities of from 50,000 to 100,000 population. The lowest rates for other cities in that population class are:

15 kwhrs—Holyoke Municipal Gas & Electric Dept., Holyoke, Mass.; Cleveland Dept. of Pub. Utilities, Lakewood, Ohio; Cleveland Elec. & Illum. Co., Cleveland Heights, Ohio, 60 cents. Cleveland Dept. Pub. Utilities is lowest for 25 kwhrs and 40 kwhrs with charges of 88 cents and $1.31 in Lakewood, Ohio. In the 250 and 500 kwhr groups, the cheapest rates are those of the City Water, Light and Power Dept. of Springfield, Ill.

Great Britain Starts Water Survey

An inland water survey of Great Britain is being started, it was announced in December by the Minister of Health. The future water policy of the country, and especially the supplying of water to small towns and even to farms, as a national health measure and possibly with national financial support, was discussed three days later by Alan E. L. Chorlton, M.P., in the course of which he said: A central statutory authority for guidance and allocation seems to be dreaded. Was there a via media? Could we—

(*a*) Divide the whole country into regional areas with advisory committees composed of representatives of each authority in the area continuing the present practice?

(*b*) Set up provincial group committees to act as linking up agents between one region and another, composed of representatives from such regions?

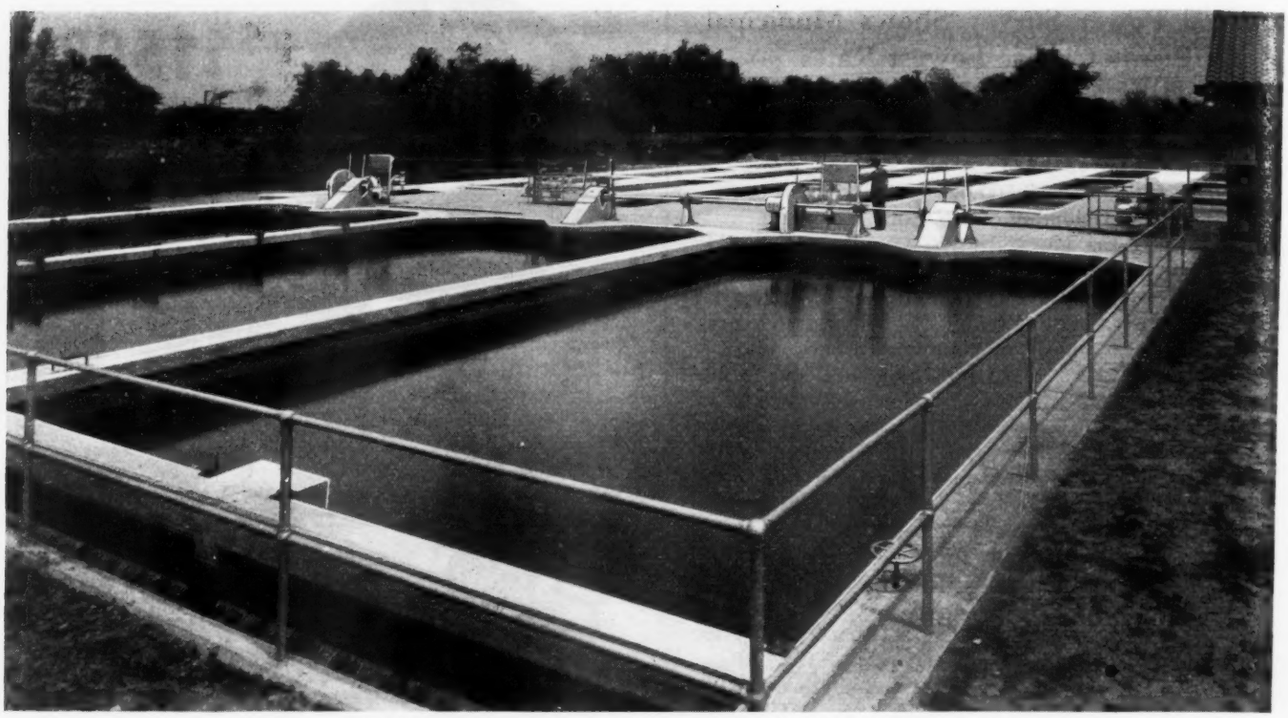
(*c*) Following this by a central body to codify the recommendations from such joint committees for the benefit of all concerned?

The central body would not undertake any work itself, nor interfere with the management of town and country undertakings. It would be a directing authority with certain statutory powers.

Profits From Municipal Utilities (Cont. From Page 32)

ciated value of $31,497; and the steam heating system one of $28,908.

During the fiscal year 1933-34 the total gross income from light, power and electric range service in the city was $53,018; and from light and power furnished to other communities, $10,208. The income from steam heating was $14,929; from water service, $6,345; from miscellaneous services $2,330. The chief operating cost was for coal, $24,365, and wages, $12,432. The total kwh output for the year was 2,404,800. The net profit after depreciation was $13,032.



View of final settling tanks, City of Springfield, Ill. Link-Belt Straightline collectors in service in both primary and final tanks. W. B. Walraven, Engineer, Springfield Sanitary District.

STRAIGHTLINE COLLECTORS *for Settling Tanks*

Link-Belt Straightline collector in final tank.

REGULAR complete removal of sludge from rectangular flat-bottom tanks is performed efficiently by the Link-Belt Straightline collector, which for more than 12 years has given unusual satisfaction in scores of plants. High efficiency, positive results, large capacity, and low first cost, with small maintenance and power expense, are some of the reasons for the trend towards the use of the Link-Belt Straightline collector. Its simple, flexible design, accessibility for inspection, durable construction and long life, make it possible to adapt this collector, economically, to any size plant from the smallest to the largest. Send for catalog.

5237

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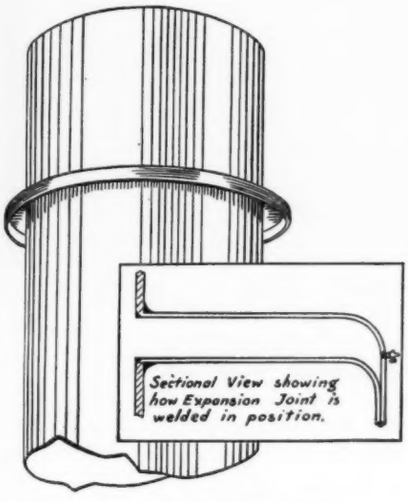
Pages 47, 48 and 52 contain descriptions of many helpful booklets—Don't forget to look them over.

New Ideas in Equipment

Expansion Joint For Long Pipe Line

An ingenious method of caring for expansion in a long pipe line has been provided in the large air duct just completed for the Milwaukee Sewage Disposal Plant. Flanged connections permit enough flexibility to prevent distortion of the pipe under longitudinal stresses.

This installation, comprising a tube of Plykrome, a stainless clad steel, ranging from 2 to 5 feet in diameter, was assembled in 54-foot lengths where it was welded into a continuous tube 1,800 feet long. Inasmuch as the tube carries 100,000 cubic feet of air per minute under a pressure of 10 pounds per square inch, perfectly welded joints were imperative to prevent leakage. The Cream City Boiler Company, who completed the work for the city of Milwaukee, used P&H Hansen welders in the fabrication and installation of the pipe.



An air-line expansion joint

This new type of expansion joint, made under patents held by the Allis-Chalmers Mfg. Company, is spaced at intervals of 54 feet. The flange, or collar, protrudes from the outer edge of the pipe from 4½ to 6 5/16 inches, depending upon the variable diameter of the tube. As shown in the accompanying diagram, the pipe connections themselves are separated by 1 inch of air space, amply allowing for expansion and contraction under the most severe temperature changes.

New Indiana Trucks:

A new streamlined Indiana truck is announced by The White Motor Company, builders of Indiana trucks and coaches. The new model, of 11,000 pounds gross capacity, marks Indiana's entry into the lowest price field. It is designed to fit every requirement of the light duty field.

Modern streamline appearance is a striking feature of the chassis, achieved by the use of deep-skirted fenders, cadmium plated radiator grille and louvres and a sedan type cab. The new truck features a powerful six-cylinder 263 cubic inch engine, hydraulic brakes and ventilated disc wheels.

Smith Porous Drain Pipe

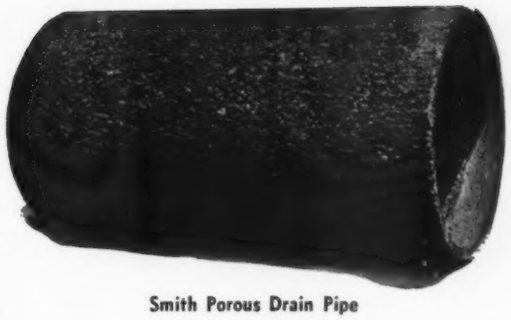
Smith porous drain pipe is made of hard, coarse, porous materials, specially prepared and bonded together with portland cement. It is porous through its entire wall surface, which permits the free and rapid flow of water, in or out of the pipe, for either drainage or irrigation.

Laboratory tests show the strength of Smith pipe to be greater than the A. S. T. M. requirements for either airports, highways or railroad work.

The entire wall being of porous construction permits the entrance of the maximum amount of water, and in much greater volume than pipes laid with openings only at joints. A four inch pipe of this type will take in more water than an eight inch ordinary pipe. The interlocking ends prevent the danger of pipes becoming filled with roots, earth or other foreign matter.

Being made with interlocking ends they can be laid in perfect and permanent alignment, and very rapidly, eliminating wrapped joints. Freezing and thawing will not disturb them. It is not necessary to use more than one-half the usual amount of crushed stone, gravel or cinder construction around the pipe, when using this pipe.

Data concerning the qualities of this pipe will be sent on request to Smith Porous Drain Pipe Corp., Gulf Bldg., Pittsburgh, Pa.



Smith Porous Drain Pipe

Quick Adjustable Screeds for Crown Elimination

Because many State Highway Departments require the flattening of a pavement surface around curves, the Blaw-Knox Company has developed a quick adjustable screed for crown elimination.

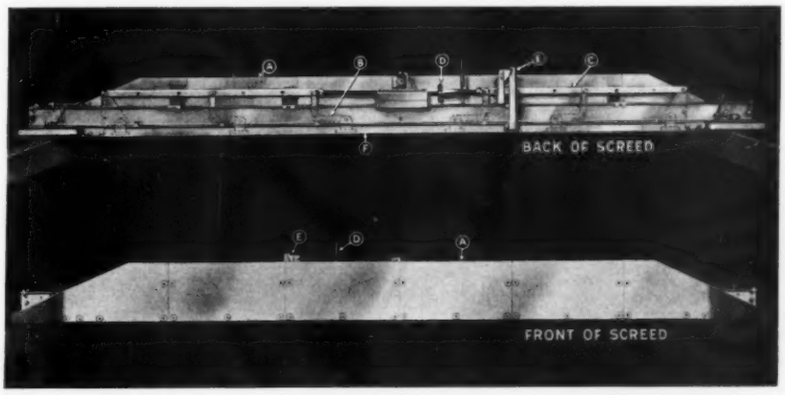
It can be installed on any Blaw-Knox Finishing Machine (either Ord or Gas-Electric Type) and can be used for either concrete or bituminous road construction.

This adjustable screed eliminates a road building operation which usually required considerable time and held up the entire job.

The following is an example of this operation: The pavement carries a 1½" crown. On entering a curve the first 75 ft. are used for transition from 1½" crown to flat, and the last 75 ft. coming out of the curve is transition from flat to 1½" crown. This transition must of course be gradual.

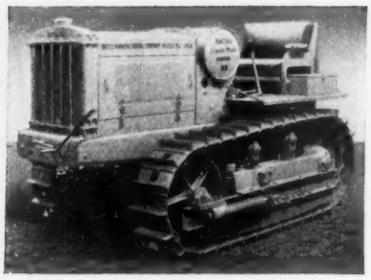
This screed eliminates a time loss on paving which ordinarily would hold up the job about three hours. Where numerous curves are encountered this time loss represents a considerable figure.

The adjustable screed remains in the finisher for both the crown and the flat section. By the use of cam levers and the operating spider, it can be gradually flattened or crowned while going through the paving transition without job delay, and while the finisher is in operation.



(a) Sectional and floating strike-off plates; (b) Cam levers for flexing the screed bottoms; (c) Cam lever links which operate all cam levers simultaneously; (d) Quick adjusting device for changing the crown of the screed; (e) Indicating gauge showing crown of screed at all various settings; (f) Screed bottom.

Some New Ideas for the Engineer



Bates "35" Tractor

A New Bates Tractor:

The Bates Manufacturing Company of Joliet, Illinois, builders of the new Bates Steel Mule, announce a new model 35 tractor.

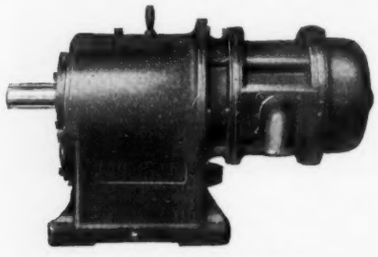
Improved design provides greater riding comfort, greater steering ease, smoother operation and longer life. Operators will appreciate the deep leather upholstered seat which has been moved back to provide more leg room. In its new location, the operator sits directly over the rear axle. The braking pressure of the steering brakes has been increased and the crawler can be stopped with a relatively light pressure of the foot. The standard Bates brake lock is mounted on the left brake pedal. By merely flexing the foot downward the tractor and its load can be held stationery on any hill position the tractor may be in.

The new Bates Model 35 Tractor has a drawbar pull of slightly over 43 H.P. and can be powered for either Diesel, Oil, or Gasoline.

Link-Belt Motorized Reducers:

In order to meet the growing demand for still greater compactness and economy in self-contained enclosed speed reducing units, Link-Belt Company, Philadelphia, Chicago, San Francisco is placing on the market a new line of Motorized Helical-Gear Reducers, an outstanding feature of which is the unusual accessibility of the motor and the high speed gears.

A standard round-frame motor conforming with National Electrical Manufacturers' Association specifications, is secured so as to assure good alignment and proper mesh of pinion with its mate. The complete motor, with adapter and motor pinion, may be removed as a unit for inspection or maintenance, without disturbing the alignment of the motor, or of the gears remaining in the reducer housing; in fact, the motor pinion and gear are removable without disconnecting the driven machine or disturbing the low speed gears.



Link-Belt Motorized Reducer

All gears are of the helical type, with teeth cut from heat-treated alloy steel. Anti-friction bearings are used throughout. Low speed shaft and its bearings are designed to carry overhung loads.

The new motorized reducers may be mounted on floor, ceiling or wall; and are available in double reduction for ½ to 75 H.P., in ratios up to 38½ to 1, and in triple reduction up to 30 H.P., in ratios up to 292 to 1. They embody the usual advantages of not requiring a motor base plate or a high-speed shaft coupling, and as the motor forms an integral part of the reducer, the proper alignment of motor shaft is definitely assured at all times.

The Blueprinter:

A blueprint machine which utilizes the new Angstrom blueprint lamp has been placed on the market by Milligan & Wright Company, 4709 Prospect Avenue, Cleveland, Ohio.

The Angstrom lamp used in this machine is of the incandescent type and operates from the regular 110-115 D. C. or A. C. lighting circuit without the need of transformer choke coils, etc. It differs from the ordinary incandescent lamp in the quality of light produced being stronger in the blue end of the spectrum.

The "Blue-printer"

The Model 100 pictured here is the portable table type which will print one 18 x 24, or two 12 x 18, or four 9 x 12 prints at one time. To make a print it is only necessary to place tracing and paper on the plate glass top, lower the pressure pad and close the cover. The springs in the cover act on the pressure pad assuring good contact between tracing and paper. The automatic time switch is turned on and set for about 1 minute exposure. (The length of exposure depends on the speed of paper used.) When the time switch clicks off remove the print and wash it in water and potash solution in trays provided for this purpose. The print is then dried on a special drying board furnished with the machine.

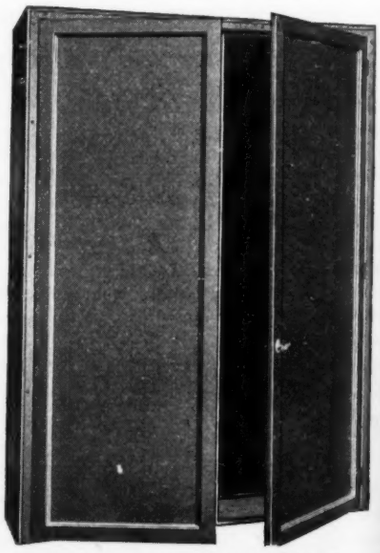
Additional features of the machine are that one print can be made as economically as a dozen, it can be operated by anyone without danger of accident or fire, no special electrical equipment required; just plug it in anywhere.

To House Your Meters:

A cabinet type steel meter panel equipped with doors to protect and conceal meter and control connections is now offered by Bailey Meter Company, Cleveland Ohio.

A panel of this type with flush mounted equipment presents a pleasing appearance not only from the front, but from the rear as well. The neatly paneled doors are provided with a 3 point locking mechanism and a substantial cylinder lock which may be used to prevent unauthorized persons from gaining access to electrical connections, control mechanism and meter adjustments located within the cabinet. The panel is finished in a smooth and luxurious black tone.

These panels are thoroughly durable, being made of one piece sheet steel plate formed in proper sizes to give symmetrical and uniform appearance regardless of the quantity or type of meters and instruments to be installed on the board. Full description on request.



Bailey Cabinet Type Meter Panel

is hauled by
INTERNATIONAL TRUCKS

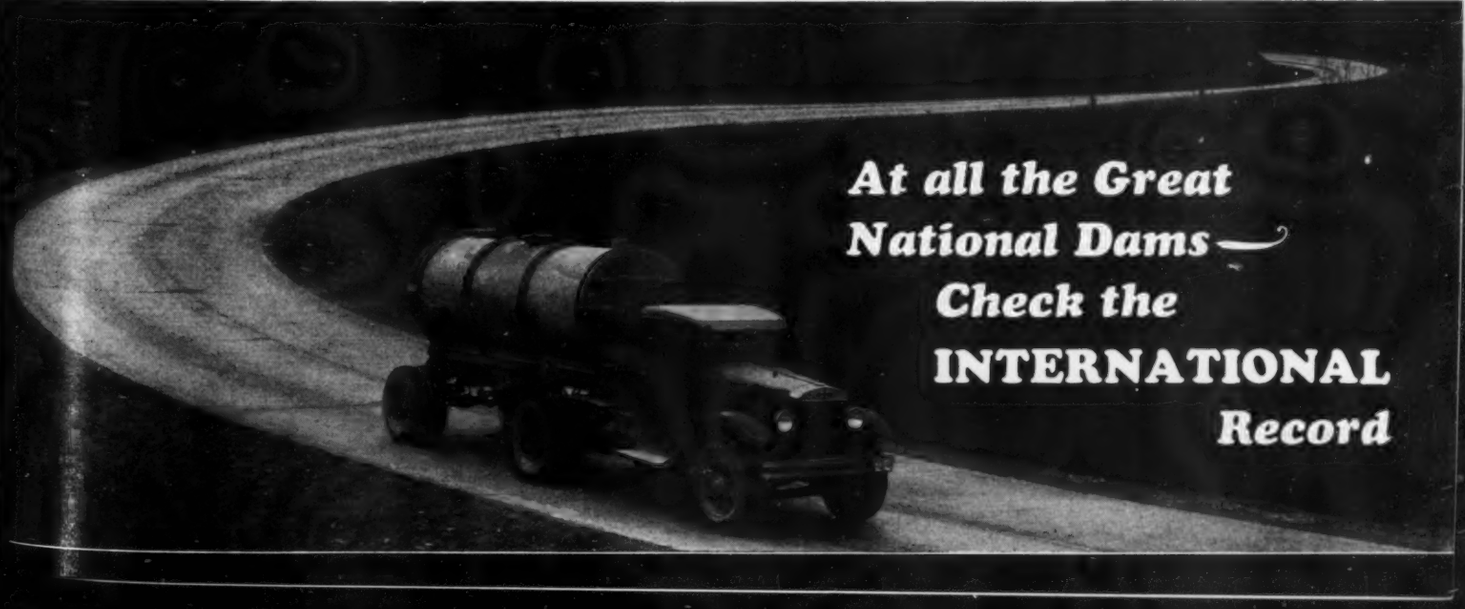
Originally a railroad was planned to get the vast tonnage of cement and reinforcement steel from the railroad siding at Coal Creek, Tenn., up to Norris Dam, but a show-down on efficiency gave the job to trucks—INTERNATIONALS.

A scenic highway 4.8 miles in length was built up the steep grades (eventually it will continue on over the completed dam) and a fleet of International Model A-8 tractor-trucks with semi-trailers got onto the job, to carry on twenty-four hours a day during the many months of dam construction. The aluminum tanks of the trailers hold a capacity of 65 bbl. or 24,440 lb. of cement. Steel and lumber are hauled on other types of trailers.

On the Tennessee Valley projects, as on the most spectacular construction enterprises elsewhere in the country, International Trucks are playing a generous part, consistently dependable, efficient, economical.

Service through 217 Company-owned branches.

INTERNATIONAL HARVESTER COMPANY OF AMERICA, INC.
606 South Michigan Avenue, Chicago, Ill.



Engineering News and Equipment

Short Course in Water Treatment

The fourth University of Florida short course in water treatment will be held in West Palm Beach, March 27-30, in conjunction with the Florida Section, AWWA meeting. Full details of the course can be obtained from Prof. A. P. Black, Gainesville, Fla.

The program will begin Wednesday evening with a talk and a film covering the manufacture and installation of Transite pipe by C. A. McGinnis, which will be followed by a paper on Boulder Dam by Prof. T. M. Lowe. Thursday forenoon, K. R. Chinn will speak on "Pipe Corrosion at West Palm Beach" and other papers will be presented as follows: "Fully Automatic Water Softening Plants," S. B. Applebaum; "Chlorine and Chloramine Control for Iron Bacteria," by C. H. Eastwood. Other papers of special interest will cover such subjects as B. Coli for Pollution Indicators, by Paul Eaton; Kinks in Operation by F. E. Stuart; Cross Connections by R. E. Tarbett, T. M. Lowe and Louva Lenert; Recent Progress in Coagulation, by L. L. Hedgepeth; Pumping by Mr. Lowe; Recent Advances in Water Treatment, by Prof. Black; Organizing for Progress and Water Supply by Harry E. Jordan; and Licensing Water Works Operators, by Mr. Lenert.

The list of tropical pastimes that go with this school and the Section meeting are very alluring. Add to this an undoubted good time and lots of good fellows. We advise all to attend.

Personal Items

H. T. Flasher has been promoted to Assistant Chief Engineer of Maintenance, Ohio Department of Highways, and has moved to Columbus, O., from Ashland.

Harry C. Child, Consulting Engineer, 501-503 So. Keystone Ave., Sayre, Pa., has been appointed to design the municipal electric light and power plant for Sayre, Pa.

Catalogs

Motor Graders:

A 20-page beautifully illustrated catalog describes the line of motor patrol graders manufactured by the Galion Iron Works & Mfg. Co., Galion, O. Ask for catalog 185.

Hose, Belting, Packing:

A 96-page, nicely bound booklet on various mechanical rubber goods. Belt speeds, steam pressures and temperatures, carrying capacities, dimensions and numerous formulas on every-day problems. No charge. N. Y. Belting & Packing Co., 1 Market St., Newark, N. J.

Roofs:

Johns-Manville Co., 22 E. 40th St., N. Y., has issued a roof book which discusses repairs, characteristics of various kinds of roofs, insulation and fuel costs, etc. Also describes a new roof unit, combining steel deck, insulation and waterproofing. Sent on request.

Want a Copy?

Taste & Odor Control is a new publication of the Industrial Chemical Sales Co., Inc., N. Y. Worth having. Write Fred Stuart to have your name on the mailing list. Talks a lot about water and a little about Nuchar.

Bituminous Distributors:

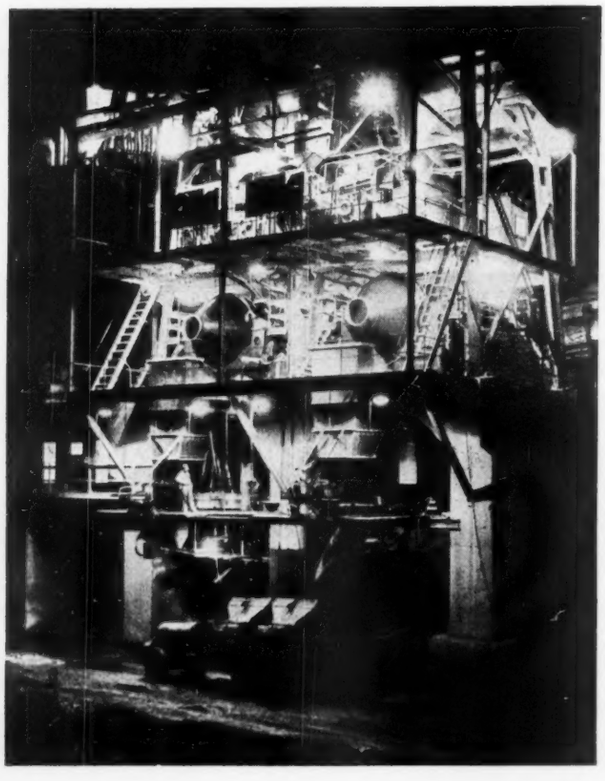
What you want to know about bituminous distributors is pretty well covered in two booklets issued by E. D. Etnyre & Co., Oregon, Ill. Engineers engaged in low cost road work will find these of particular value. Sent on request.

Street Flushing:

Not only descriptions of modern equipment for modern street cleaning, but some worthwhile information on the subject. Write E. D. Etnyre & Co., Oregon, Ill., and ask for booklets 302 and 303.

The Rome Road Grader business, formerly owned by Rome Manufacturing Company, Division of Revere Copper and Brass, Inc., has been purchased by a group headed by J. M. Patterson, who previously managed this department for Revere. A new company has been formed under the name Rome Grader and Machinery Corporation, to take over this business.

The new organization plans to be in production about the middle of March with a full line of Rome "High Lift" Drawn Graders, Rome Motor Graders, and Rome Auto Mowers, and will later add additional items in the road building equipment line.



The T. L. Smith Co., Milwaukee, has furnished three 3-yard mixers with wear-resisting linings for Norris Dam, near Knoxville, Tenn., similar to the six 4-yard mixers used at Boulder Dam. A feature of interest is the wear resisting linings, which are applied electrically, resulting in greatly increased life.

Material Prices

(Published for information only)

(February 28, 1935)

Warehouse Prices on Reinforcing Steel and Structural Shapes

	Structural Shapes	*New Billet Reinforcing Bars*
New York	3.37c	2.82
Boston	3.52	—
St. Louis	3.44	—
Cincinnati	3.40	3.25
Pittsburgh	3.15	2.90
Chicago	3.20	—
Philadelphia	2.95	2.955
Cleveland	3.31	2.60
San Francisco	3.55	3.50

Prices on cast iron pipe, net per ton, Class B, 6-inch and larger, AWWA specifications*

Boston	$47.50	Baltimore	$45.50
New York	44.90	Atlanta	42.00
Chicago	46.00	Birmingham	38.00
Minneapolis	48.50	Kansas City	48.15

Burlington, N. J., $42.00; extra price for 4-inch,, $3.00 per ton; extra for Class A, $3.00 per ton

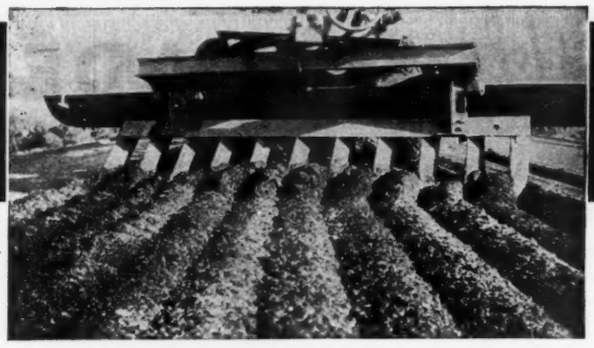
**Information, courtesy U. S. Pipe & Foundry Co.*

Warehouse Prices on American Pig Lead

Per pound

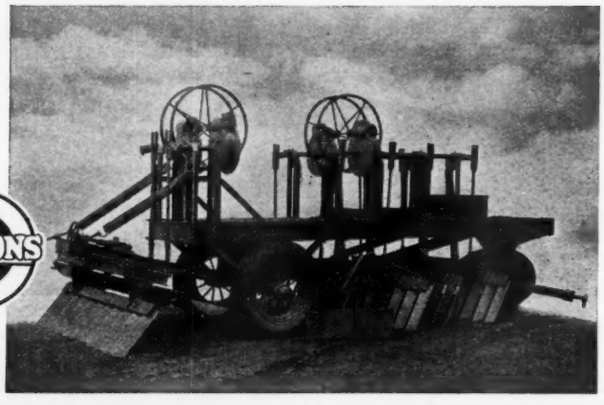
New York	4.50 to 5.50
Cleveland	4.50 to 4.75

Pages 47, 48 and 52 contain descriptions of many helpful booklets—Don't forget to look them over.



PARSONS TURBO MIXER

REDUCES COSTS IMPROVES OUTPUT



THE Turbo has already been approved in eight states under widely varied specifications and materials.

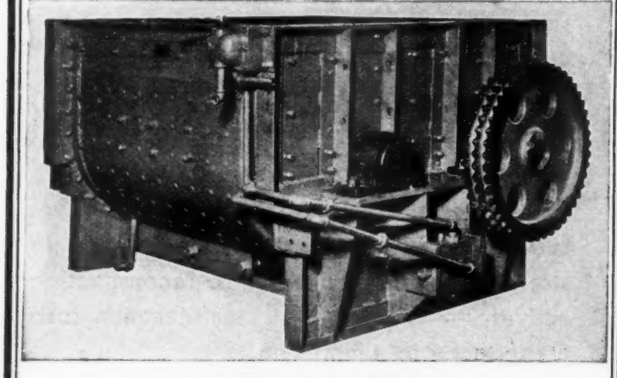
(a) Better application of the tractor power.
(b) Greater depth of material handled.
(c) Faster mixing action.
(d) More uniform results in texture and finished surface.
(e) Better application of power saves time and fuel.
(f) Doubles the effectiveness of present tractor or blade equipment.
(g) Handy to operate—easily transported.

Write for details. We have a representative near you.

THE PARSONS COMPANY, INC.
NEWTON IOWA

STEAM JACKETED STEAM OPERATED ASPHALT MIXERS

For Bituminous Mixtures of All Kinds

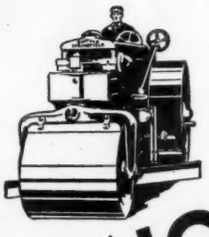


COMPACT DESIGN
WELDED STEEL CONSTRUCTION
ANTI FRICTION BEARINGS
ADJUSTABLE & REMOVABLE BLADE TIPS

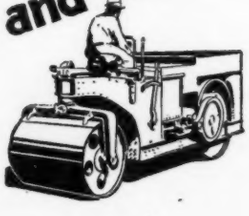
Send for Bulletin P-234

HETHERINGTON & BERNER, Inc.
INDIANAPOLIS, IND.

Builders Of Asphalt Paving Machinery For 30 Years



BUFFALO-SPRINGFIELD Three Wheel and Tandem



Buffalo-Springfield's complete range of models in both three-wheel and tandem rollers permits the purchaser to select the proper machines for his work.

Full details will be furnished on request.

THE BUFFALO-SPRINGFIELD ROLLER CO.
SPRINGFIELD, OHIO

Pages 47, 48 and 52 contain descriptions of many helpful booklets—Don't forget to look them over.

What Can Be Done With 2,000,000 Miles of Rural Roads

(Continued from page 17)

Calcium chloride is applied to soil surfaces at the rate of about one-half pound per square yard per inch of thickness of road surface and preferably should be mixed with the graded surfacing material. Indiana requires not less than three-fourths of a pound of common salt per square yard per inch of surface thickness, with the additional requirement that the salt shall be applied in a solution of about 8 pounds of salt to 5 gallons of water.

It is believed that the high densities of road surfaces treated with calcium chloride and salt are not due entirely to the deliquescence of the materials but are in part due to electrolytic effect in reducing the thickness of the moisture films.

It is possible that chemicals such as calcium chloride and common salt, which serve to lower the freezing temperature, might be beneficial in the colder climates in their effect on freezing.

Dr. Strahan has found that: "When coarse material is added to a good soil mortar in appreciable amount (10 percent or more) the hardness and durability of the surface is increased and continues to increase until a full gravel-type surface is reached."

The chemically treated surfaces are firmly bound and offer great resistance to raveling under traffic. Smoothness is maintained without the loose surface mulch often used on untreated gravel roads. In fact, the presence of mulch may act as an abrasive under the wheels of vehicles and thus prove detrimental.

The purpose of this type of stabilization is to produce a semisolid and dense soil-road surface which is not affected by moisture and is capable, when suitably surface treated, of serving a considerable volume of traffic. The method is suitable for use where only fine-grained soils abound as well as in those locations having granular materials and binder available for use in graded soil mixtures.

Selected soil surfaces are suitable for temporary surfacing on important roads. They can be placed immediately after the grading for use during the period of settlement and will give substantial support and increased life to pavements placed upon them.

A good mixture for the repair of areas in which pitting has occurred consists of aggregate under one-half inch in size, mixed with at least an equal weight of stable sand-clay. To insure that the patching materials will be moist enough to stick securely in the hole, the admixture of 100 to 150 pounds of calcium chloride per cubic yard is recommended.

The manner in which local materials are selected for use in soil roads was excellently described by G. A. Rahn, of the Pennsylvania Department of Highways, before the 1934 convention of the American Society for Testing Materials. In one case the soil of the original road was taken to the laboratory and on test was found to be a silt loam. Since stone screenings were available near the location of the road for use as admixture, tests were made to determine the amount of admixture required to change the soil to the more stable A-2 type. With this information as a guide, the screenings were applied to the old road and worked in until tests disclosed the proper amount had been added. Some time later calcium chloride was applied to the surface.

Chemical Treatment of Sewage

(Continued from page 15)

conjunction with various chemical treatment processes. The use of chlorine as an odor preventive and corrective is well-known. Many of the coagulants, particularly ferric salts, in common use are also more or less specific for correction of odor nuisance. Where odors may be a problem, this factor is important to consider in connection with chemical methods of treatment, particularly where a plant can be most economically located near residents.

Chemicals Used

Chlorine, it may truly be said, has been the most important chemical used in the sewage treatment field during the past decade. A multiplicity of benefits to be derived from its use lead one to approach many problems with the query: "Would chlorine be of aid in this instance?" The use of chlorine as a disinfecting agent is of prime importance and well established. Correction of odor nuisances has been demonstrated. Allowance is made for increased reductions of B. O. D. where chlorination is practiced. The prevention of septic conditions in settling tanks with resulting higher removals of solids by such tanks has been shown. Its use as a corrective for "pooled" trickling filters is well known. Reports have also been made of the prevention of

5. Spreading pulverized clay

6. Blading in windrows

"foaming" of digestion tanks and increased grease removal where pre-chlorination was used. But in connection with modern chemical treatment methods, chlorine has been found of great value both as a stabilizer and aid in effecting coagulation. Where iron salts are used, chlorine is frequently used to maintain such salts in the ferric state.

Lime is one of the oldest chemicals used in sewage treatment. Many of the old-style plants used lime alone or in conjunction with copperas or alum as a precipitant. It has been found of great aid in maintaining the proper conditions in digestion tanks and its use in chemical coagulation methods is being continued.

Activated carbon is one of the newer chemicals to find use in the sewage treatment field. At Fairport, N. Y., it was found that this material in relatively small doses prevented scum formation on the secondary settling tank, thereby producing an improved quality of effluent. Preliminary results of the use of this material at East Rochester, N. Y., showed that increased rates of digestion and accelerated gas production followed its introduction into the raw sewage.

Iron coagulants. The commercial development of ferric chloride, ferric sulphate and other iron coagulants has contributed greatly to the return of chemical methods of sewage treatment. These chemicals constitute the basic reagents of most chemical plants today.

Limitations of Chemical Treatment

We must recognize some of the limitations of chemical treatment methods. For example, it will be difficult to remove much of the organic matter in solution in the raw sewage. Therefore, wastes or sewages high in soluble organic solids may not be handled satisfactorily by chemical treatment. The problems of each particular locality must be studied individually. Just as it is true that no two water supplies are exactly alike, it is more true that sewages from different localities are widely different in physical and chemical characteristics. Therefore, treatment methods must be chosen only after a comprehensive study of the particular sewage to be treated and the demands of the receiving watercourse.

Careful control of the chemical treatment plant will be necessary to secure effective and economical operation. The plant operator must have some technical knowledge and appreciate the importance of careful regulation of chemical dosages, mixing, and subsequent treatment.

The development of modern chemical treatment methods has opened up several new fields in sewage treatment practice. There is every reason to believe that chemical treatment will find increased use, now that many of the problems of the old-style plant have been solved.

Tadpoles in Reservoirs

Tadpoles in the reservoir of the Ellwood (Pa.) Water Co. were so numerous during April and early May for several years that the 6 m. g. reservoir 375 ft. by 250 ft. showed a black band of tadpoles 6 to 9 in. wide around the entire shore line. Several remedies were suggested but the final solution was the placing in the reservoir of bass 12 to 18 in. long. "This species was selected because they are of a ferocious type and are scavengers." On a very warm day early in April, 42 bass were placed in the reservoir, which was covered with spawn, and there was no trouble with tadpoles this spring—only with night fishermen trying to catch the bass. The fish seem to be immune from the effects of chlorine and copper sulphate, doses of 8 lb. per m. g. of the latter having had no effect on them.